Scalable Computing: Practice and Experience, ISSN 1895-1767, http://www.scpe.org

Volume 26, Issues 3, pp. 1196–1211, DOI 10.12694/scpe.v26i3.4382

PRODUCT OPTIMIZATION DESIGN OF ELECTROMAGNETIC EMISSION NET CATCHER BASED ON TRIZ THEORY USING SCALABLE COMPUTING

XIAOBO JIANG[*], ZEQUN XU[†], AND WANYI LU[‡]

Abstract. Improving the effectiveness and security of electromagnetic interference (EMI) management in different contexts relies heavily on optimising electromagnetic emission net catchers. Scalable computing in conjunction with the TRIZ (Theory of Inventive Problem Solving) provides a methodical strategy for invention, facilitating the methodical resolution of problems and enhancements to the design of intricate engineering systems. Electromagnetic interactions, design parameter precision, and improved material integration make electromagnetic emission net catcher design and optimisation difficult. Large-scale simulations and data processing require scalable computing technologies to simulate and analyse these systems. Using scalable computing, this research presents Automated Decision Inspection Optimization System (ADIOS), based on TRIZ theory, to optimise the design of electromagnetic emission net catchers. Finding and fixing design issues is effortless with ADIOS because it combines TRIZ with machine learning, analytics, and big data. Process and analyse massive datasets efficiently due to the system's usage of a distributed computing architecture, which handles vast computational workloads. The suggested ADIOS framework can be used in aerospace, telecommunications, and automotive industries where EMI management is critical. Electronic systems operate better, interfere less, and meet strict regulatory criteria by optimising electromagnetic emission net catchers. The ADIOS framework's efficacy and scalability are assessed using simulation analysis. The outcomes prove that the system can efficiently and accurately handle complicated design scenarios. The investigation shows that ADIOS can optimise design parameters and come up with new ideas to improve electromagnetic emission net catchers.The proposed method increases the Electronic System Performance ratio of 99.25%, Electromagnetic Interference Management ratio of 98.41%, Efficiency ratio of 98.21%, Scalable Computing ratio of 96.31%, and Design Processes ratio of 96.24% compared to existing methods.

Key words: TRIZ, Optimization, Electromagnetic, Scalable Computing, Problem Solving

1. Introduction. The combination of high frequency, large current, and high voltage in a constrained vehicle area quickly degrades the electromagnetic environment [1]. Studying electromagnetic compatibility (EMC) circumstances always takes human exposure situations into consideration, as the EV is a radiation emitter and places where people go as drivers or passengers [2]. Several elements, including the signal's frequency and polarization, as well as environmental characteristics, contribute to the quantity of electromagnetic radiation absorbed by the body because of the shielding effect [3]. Automative vehicles must adhere to certain component and vehicle level EMC standards to ensure that on-board electronic and electrical components do not cause other equipment components to malfunction due to EMI [4]. To simplify its practical application, the other one uses transfer functions to characterize the conducted and radiated processes while ignoring the internal intricacies [5]. It is useful for evaluating the EMC performance of airplanes since it breaks down big, complicated systems into many subsystems based on the electromagnetic shielding level [6].

As the impedance of the linked ports changes, so does the precision of the transfer function, which in turn affects the forecast confidence level [7]. What this means is that to have accurate transfer functions, all the real parts need to be there and linked properly, and if anything changes, the entire system's model will change as well [8]. In response to these issues, this study presents a topology-based approach to forecast 150 kHz to 30 MHz EMI at the vehicle level [9]. To represent the EMT subsystem independently using multiple technologies, this approach uses multi-port networks, which dissociate the typical coupling between ports and transfer pathways [10]. To solve the radiated EMI analytically, the algebraic equation of this topological model is generated as a bonus, this model's sensitivity analysis reveals the primary source of interference [11]. Combining the TRIZ framework for logical and systemic problem-solving with the insights into customer demands provided

[*]Hubei University Of Technology, Wuhan, Hubei, 430022, China (Corresponding author, 15927010701@163.com)
[†]Hubei University Of Technology, Wuhan, Hubei, 430022, China
[‡]Hubei University Of Technology, Wuhan, Hubei, 430022, China

by scalable computing, this study suggests a new product design technique [12].

The goal of this combination is to achieve optimal product design in its whole by overcoming the shortcomings of the individual approaches in ADIOS framework [13]. An in-depth analysis of a capsule heater design demonstrates how TRIZ's systematic approach to tackling problems can be easily combined with the user-focused principle of scalable computing, skilfully addressing both technical and user-based design concerns [14]. This research shows how important it is for industrial designers to employ an integrated methodological approach when dealing with difficult customer needs and market obstacles [15]. While this research does acknowledge the requirement of contextual adaptability when applying the TRIZ integration to diverse product kinds and market situations, it also acknowledges the limits of this approach [16].

Taking the working point migration of permanent magnets into account, this research proposes a novel method to resilient design for electromagnetic devices [17]. The manufacturing process and the migration of the permanent magnet operating point are two important elements that are thoroughly considered in ADIOS approach [18]. To begin, eliminate the impact of robustness design and optimization by analysing the interactions among the important EMD parameters this will allow us to decrease the number of models while also improving their accuracy [19]. To enhance the efficiency and accuracy of the electromagnetic devices' approximate modeling, a high-order response surface approximation model is constructed for the EMDs [20].

The main contribution of this paper is as follows:

- The paper integrates TRIZ with scalable computer technologies in a novel way. This innovative combination allows systematic and logical problem-solving and optimization in complicated engineering systems, such as electromagnetic emission net catchers.
- The paper presents the ADIOS, which combines TRIZ, machine learning, analytics, and big data. ADIOS automatically identifies and resolves design flaws, optimizing electromagnetic emission net catchers. This approach has great potential to improve design processes.
- The research uses comprehensive simulation analysis to demonstrate the ADIOS framework's efficiency and scalability in complicated design process. Applications in aerospace, telecommunications, and automotive demonstrate the framework's usefulness in enhancing electronic system performance, electromagnetic interference management, and meeting strict regulatory criteria.

The remaining of this paper is structured as follows. In section 2, the related research work of optimization design of electromagnetic emission is studied. In section 3, the proposed methodology of ADIOS is explained and in section 3, the efficiency of ADIOS is discussed and analysed.

2. Related works. The intricate behaviour of electromagnetic waves in conductive and dielectric materials makes their design a difficult engineering task. From resonances and waveguiding to bandgaps, metamaterials, and topological effects, these rich dynamics even in linear media give birth to a plethora of phenomena that enable engineers and researchers to develop ever more sophisticated and efficient systems and gadgets. An important part of this process is optimization, which may range from fine-tuning a few geometrical features to planning the whole structure around abstract functional requirements.

Numerical Computational Technique (NCT). A soft HFSS software is used for numerical modeling and simulation of the heat sink. A shielded semi-anechoic chamber that confirms to FCC/CISPR standards for EMC measurements was used to conduct experimental examination on the heat sink. The simulated findings were determined to be in excellent agreement with the experimental results. Using Taguchi's Design of Experiments with the orthogonal array approach in Minitab, L27 combinations were created. It used simulation to look at the radiated emission of the L27 combinations that were created. For optimization, the following characteristics are considered: heat sink width and length, fin height, base height, number of fins, and fin thickness [21].

Artificial Neural Network (ANN). It includes a thorough examination of relevant literature and the methodical implementation of a simulation approach. The suggested method verifies a finite element model, showing that the objective function model values and the optimized parameter simulation values have a limited maximum relative error. Consequently, ANN optimization method significantly improves the efficiency of electric cigarette warmers. It gives a scientifically based way for improving these devices, and it also fixes the flavour and output rate problems with current electrically heated non-combustible cigarette smoking setups[22].

Nano Sensor Technology (NST). Nano sensors need to talk to one other, look at a few fascinating uses of wireless nano sensor networks. Nano sensor devices may be easily integrated into preexisting communication

Table 2.1: Summary of existing methods

Methods	Advantages	Disadvantages
Numerical Computational Technique (NCT)	Provides precise and accurate computational results. Effective for modeling complex systems.	- Limited adaptability to real-time changes. - Can be computationally intensive, leading to slower processing times in dynamic environments.
Nano Sensor Technology (NST)	- High sensitivity and precision in detection. - Low power consumption and miniaturized size.	- Primarily focused on detection with limited integration into broader optimization systems. - Less effective in real-time decision-making and system control.
Internet of Things (IoT)	- Facilitates interconnected systems and real-time data sharing. - Enables remote monitoring and control.	- Challenges inefficient data processing and real-time decision-making. - Security and privacy concerns due to the interconnected nature of devices.
Conventional Neural Networks (CNN)	- Highly effective in pattern recognition, image processing, and complex data analysis. - Strong generalization capabilities with large datasets.	- Not designed for real-time decision-making and optimization. - Requires large amounts of labelled data and substantial computational resources for training.

networks using a novel network design. A road map for the development of this new paradigm in networking is defined by highlighting the communication issues related to terahertz channel modeling, information encoding, and protocols for nano sensor networks [23].

Internet of Things (IoT). Digital forensics has benefited from the proliferation of new evidence sources made possible by the IoT. The use of lightweight data encryption, such as elliptic curve cryptography, the variety of manufacturers, and the absence of common interfaces all contribute to making data acquisition from the IoT a challenging process [24]. One new way to get data that might be helpful for forensics from IoT devices is electromagnetic side-channel analysis, or EM-SCA. However, most digital forensic investigators lack the domain expertise and specialized equipment necessary to successfully execute EM-SCA assaults on IoT devices.

Conventional Neural Networks (CNN). A CNN-LSTM hybrid deep learning neural network architecture was used to predict the most extreme high-variance emission values. Various DNNs were taught by Cetecom GmbH of Essen, Germany, utilizing actual EMI measurements taken in a Semi Anechoic Chamber (SAC) for various equipment under test (EUT). The time needed to complete the last measurement phase is significantly decreased by making predictions about the turntable's azimuth and the antenna's height [25].
The NCT makes use of Taguchi's Design of Experiments to improve the use of HFSS software for heat sink modeling. By using finite element modeling, ANN enhance the efficiency of electric cigarette warmers. When it comes to wireless nano sensor networks, NST is there to fix the communication problems. The challenges of data collecting for digital forensics, particularly the usage of EM-SCA, are brought to light by the IoT. As a last step, electromagnetic interference measurements use a CNN-LSTM hybrid model to forecast high-variance emission values. Table 2.1 shows the summary of existing methods.

The proposed Automated Decision Inspection Optimization System (ADIOS) addresses critical gaps in

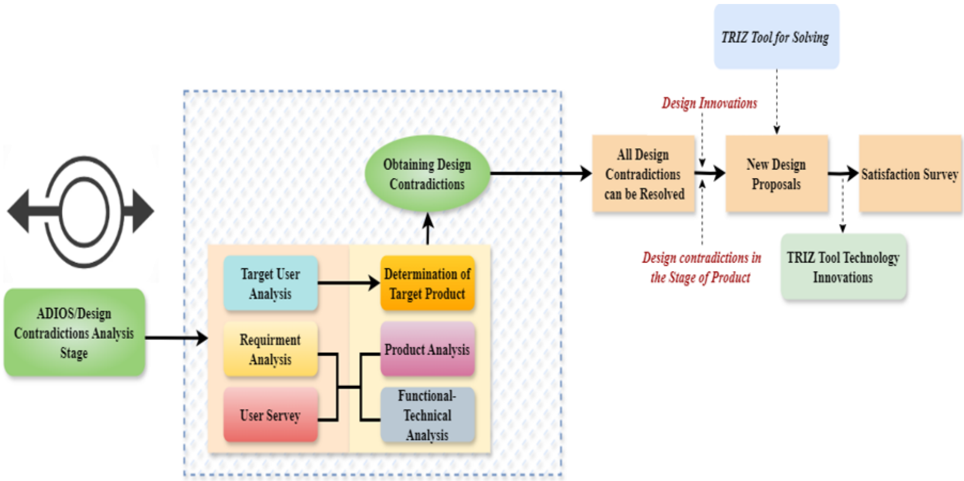

Fig. 3.1: TRIZ technology in product optimization design

current approaches, including Conventional Neural Networks (CNN), Internet of Things (IoT), Numerical Computational Techniques (NCT), and Nano Sensor Technology (NST). While NCT can do accurate calculations, it can't handle changes in real-time. While NST is excellent at detecting, it isn't up to snuff when it comes to optimizing systems, and the Internet of Things (IoT) is excellent at collecting data but has a hard time making good decisions. Despite their effectiveness in pattern recognition, convolutional neural networks (CNNs) are not usually optimized for use in real-time. By combining the capabilities of adaptive optimization and real-time decision-making, ADIOS provides a unique solution that dynamically and comprehensively optimizes the performance of electromagnetic emission net collectors.

3. Proposed method. Through the integration of design optimization, modelling, performance improvement, EMI control, and regulatory compliance, the ADIOS framework offers a systematic way to enhancing electromagnetic emission net catchers. To guarantee that designs are dependable and efficient, ADIOS employs sophisticated algorithms, TRIZ principles, and thorough analysis.

Objective 1: Innovative Integration of TRIZ and Scalable Computing. The fundamental principle of TRIZ theory is to provide creative answers to design-related paradoxes and conflicts to spur product design innovation. How a product develops throughout time is identified by the ongoing settlement of product-inherent conflicts. The ADIOS is a tool for methodically resolving technical problems and finding the best possible solutions.

Building a model for product innovation design according to the TRIZ-ADIOS integrated innovation method's methodology. Below is a diagram that shows the main components of this concept use TRIZ in conjunction with ADIOS to isolate design conflicts. The first step is to gather information about the product's intended consumers via a survey and an analysis of their requirements. This is used to establish the appropriate product's positioning and to study design issues to find and understand inconsistencies. After that, the design contradictions of the product are derived through an analysis and synthesis of technical issues related to the product's functions, structure, materials, and design using the product innovation design through Integrated ADIOS Methodological framework, which considers factors related to human-computer functionality based on user needs. To resolve the conflicting difficulties, new design solutions are generated by using the TRIZ theory and its tools to develop a contradiction matrix. This matrix will solve the detected contradictions. The design strategy for the product is established by conducting a customer satisfaction survey to confirm the suggested solution is shown in figure 3.1.

$$M(C) = \frac{1}{\forall P} + \int_{=b}^{b} \frac{B^{-\alpha 2}}{V^{\epsilon\delta}} = \gamma \int_{0}^{\Delta} hv^{-gv-\frac{1}{2}} \tag{3.1}$$

Equation 3.1 is relevant to the suggested approach M(C) since it highlights how the optimization process incorporates scalable computing $\frac{1}{\forall P}$ and TRIZ theory $\frac{B^{-\alpha 2}}{V^{\epsilon\delta}}$ The integral γ represents the continuous improvement made possible by scalable determining in evaluating $hv^{-gv-\frac{1}{2}}$ and maximizing intricate engineering systems eq.

$$\left[\int_0^{3y}\int_0^{2q} jf^{-hp2}rs + mk + f\delta\right]^{\frac{1}{2}} = \left[\rho\delta\int_0^{\mu} mq + (-\tau v)\right]^{\frac{1}{2}} \tag{3.2}$$

Equation 3.2 shows how complicated the ADIOS framework's design and optimization procedures f^{-hp2} are mk and $f\delta$ This shows the complex relationships between the optimization criteria $\rho\delta$, design elements (such as electromagnetic parameters mq and material qualities τv), and nested integrals and exponents.

$$\int_{-\alpha}^{\alpha} sj^{-ber^2}sw = \left[\int_{-w}^{s} cwf^{-kpe}sf + \int_{-1}^{1} rs + bzd^{-rwq} - fs\right]^{\frac{1}{2}} \tag{3.3}$$

Equation 3.3 encapsulates the complex nature sj^{-ber^2} of the design problems that the ADIOS framework attempts to solve sw. The convoluted integrals cwf^{-kpe} and exponents represent the complicated interactions between magnetic characteristics sf and material qualities. To handle these complicated computations bzd^{-rwq}, ADIOS makes use of scalable computing fs.

$$(e_1 b + y_2) = \frac{g_{y_1} j + h_2 z b^2 - (y_1 g_e + r_n a(s+1) + g_2 rs(p+1))}{(g_f(m+1))^2} \tag{3.4}$$

The optimization of design parameters is a complicated process $e_1 b$, as shown in equation 3.4 which contains the balance of several variables including material qualities y_2, electromagnetic considerations $g_y 1j$, and structural features $h_2 z b^2$. Efficient problem-solving y_1 g_e and accurate optimization $r_n a(s+1)$ of microwave emission net catches. Adherence to rigorous regulatory criteria $p+1$ and substantial performance enhancements $g_f(m+1)$ are guaranteed by this method.

The ADIOS framework, which is used to optimize the design of electromagnetic emission net catchers, is shown in Figure 3.2 along with its components and process. At its heart, ADIOS combines state-of-the-art machine learning with big data analytics and scalable computing with TRIZ theory. Several critical components are supported by a distributed computing architecture that manages this integration. The goal of the design parameter optimization module is to improve performance by honing design requirements. The module for electromagnetic simulation simulates interactions to foresee and alleviate any problems. To make better decisions all the time, the feedback and optimization module iterates on the outcomes. These components work together to enhance the design of electromagnetic emission net catchers, which in turn benefit a few different application areas. Aerospace, telecommunications, and automotive sectors may greatly benefit from the framework's thorough approach, which utilizes state-of-the-art technologies and processes. It guarantees that designs are optimized for efficiency, reliability, and compliance with regulatory requirements.

$$(w_1(b-1) + y_1) = \frac{(dwq(bt) + hes(Fp)) \to ((py, wq(JK - sp)))}{bk(n-1)} \tag{3.5}$$

Equation 3.5 illustrates the ADIOS framework $w_1(b-1)$ optimizes several design parameters alongside the way these interact y_1 with one other. The ADIOS system uses TRIZ $dwq(bt)$ and scalable computing $bk(n-1)$ to optimize and manage these complicated interactions $hes(Fp)$, which in turn allows for new solutions $wq(JK-sp)$ and accurate modifications in the design of net catchers that capture electromagnetic emissions py, wq.

$$\partial(by) = \int_0^d gw(xv+2) - gh(v-1)wr = \frac{(wr - ty)}{cz} - \frac{c}{sq - rw} + \left(1 - \frac{c}{fr}\right) \tag{3.6}$$

Equation 3.6 illustrates how ADIOS $gw(xv+2)$ intricate interdependencies in design optimization $\partial(by)$. The ADIOS framework takes $gh(v-1)wr$ scalable computing $((wr-ty))/cz$ and TRIZ to smoothly manage these

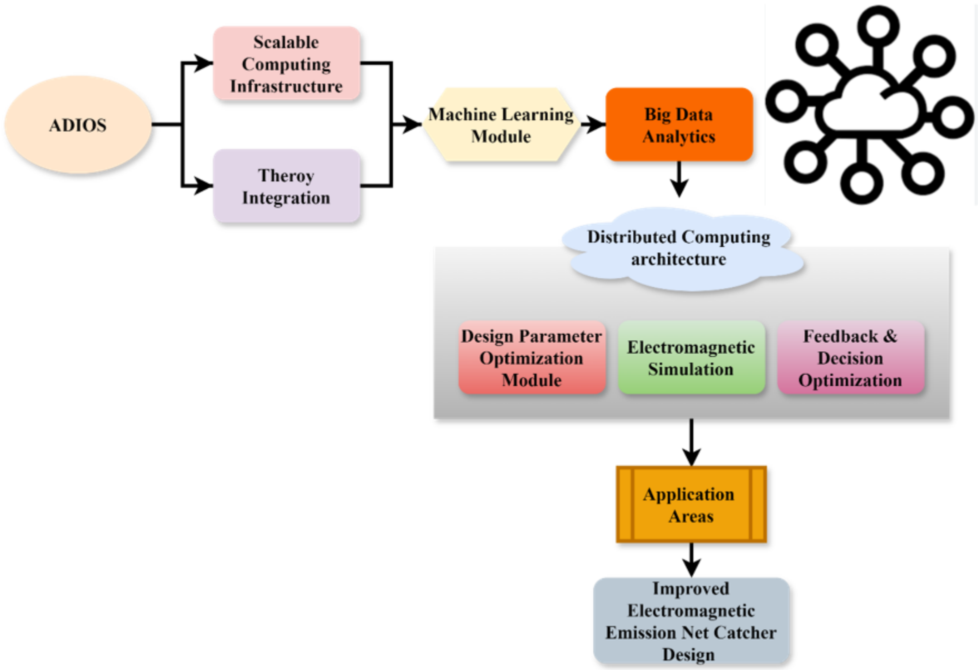

Fig. 3.2: Architecture of electromagnetic emission net catcher based on ADIOS

complex interactions $c/(sq - rw)$, allowing for accurate parameter adjustment $1 - c/fr$ and analysis in electromagnetic emission net catchers.

$$rs = \frac{1}{2}UHp + ysa_1 = \left(h - N(1 + \frac{sw}{ap})gh_k\right) + (kp + 1) \tag{3.7}$$

Multiple design performance factors rs interact in the optimization process, as shown in equation 3.7. Through methodical analysis U Hp and optimization ysa_1 of parameters in electromagnetic emission net catchers $N(1 + \frac{sw}{ap})$, the ADIOS framework efficiently controls these complicated interactions using scalable computing ghk and TRIZ $kp + 1$.

$$h(r, s) = \sum_{q=0}^{+\partial} \frac{n + (yp) - (sq)}{pf!} + (c + wq)^n + (pz - ew) - (frs) = \sum_{m=0}^{v} (q - p) \tag{3.8}$$

The optimization of the design is affected by several complicated elements (yp) and (sq), the total of which is represented by equation 3.8, $h(r, s)$. The ADIOS methodology allows for effective solutions $(c + wq)^n$ in the construction by methodically analyzing $pz - ew$ and optimizing these complicated interactions frs using scalable computing $(q - p)$.

In summary, through a natural integration of TRIZ and ADIOS the user requirements analysis of EMI is used to identify design conflicts at the initial design phase. These contradictions are then included into TRIZ. scientific principle. Then, to achieve innovation in product design, TRIZ tools are used to build a contradiction matrix. Then, creative concepts are used to overcome the contradictions in the matrix.

Objective 2: Develop and Implement ADIOS Framework. To get useful insights from this cleansed and organized data, analytics and machine learning are used. The TRIZ technique, which includes a problem identifier, TRIZ principles, and solution development, lies at the heart of this framework. While the optimization engine recommends actions to be executed by automated actuators, visualization and human control choices

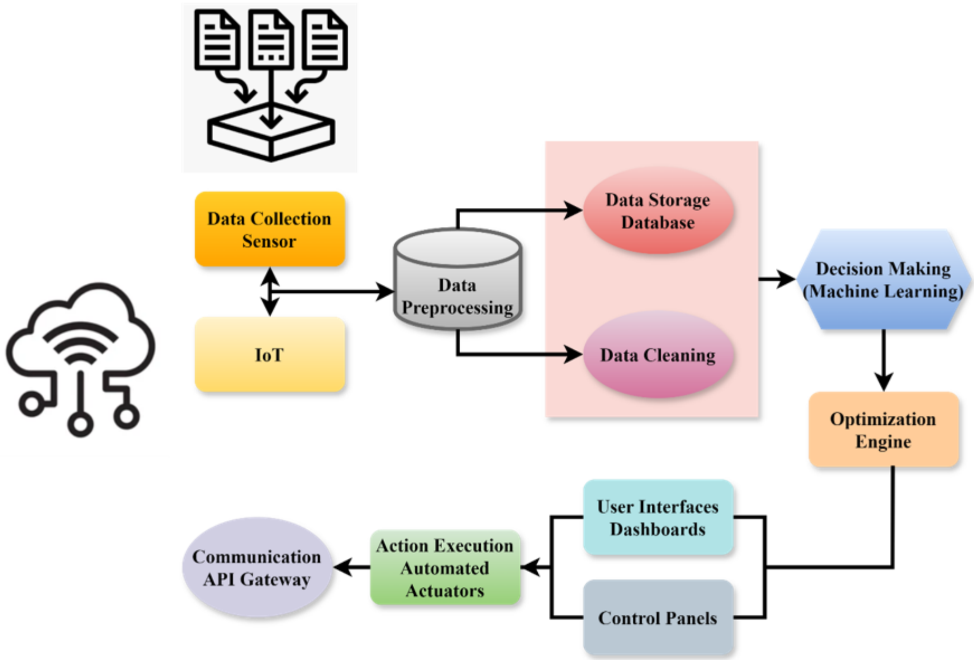

Fig. 3.3: Automated decision inspection optimization system

are provided via user interfaces, dashboards, and control panels. The IoT, machine learning and data analytics provide a thorough foundation for process optimization which is shown in figure 3.3. Data gathering sensors are the first step in this process; they input information from a variety of sources into the IoT ecosystem. Before being saved in a database for future analysis, the acquired data goes through preprocessing, where it is cleansed. The optimization engine's decision-making module, which is fueled by machine learning techniques, uses the cleaned data afterwards.

By analyzing the data, this engine can improve several settings and provide useful insights. The smooth integration and interaction of various system components is guaranteed by communication over an API gateway. Industries such as smart manufacturing, healthcare, and urban infrastructure management greatly benefit from this networked system since it improves efficiency, accuracy, and decision-making across a variety of applications.

$$fbq + ew + I(\tan RW) = (\sin -q(m+w))^{hjp-r} = gf_{wq}^{s+1} \tag{3.9}$$

In the optimization process fbq, the intricate interplay of geometric ew, accelerating $I(tanRw)$, and algebraic components are shown by equation 3.9. The ADIOS framework simplifies the design sin by successfully managing and optimizing $hjp-r$ these numerous interactions using TRIZ gf_{wq}^{s+1} and scalable computing $m+w$.

$$\delta.\Delta \in b = E\frac{zf}{s^2CF} + \frac{c_2B(z+q)}{bwq^2} - \frac{1}{\cos wjk^2}(k-je) \tag{3.10}$$

The complex interdependencies between $\delta.\Delta \in b$ the many design and performance factors $Ezf/(s^2CF)$ are shown by equation 3.10. To handle these intricate interrelationships $c_2B(z+q)$, the ADIOS framework TRIZ and scalability computingbwq^2, which enables systemic optimization of net catchers for electromagnetic emissions $1/(coswjk^2)$. Improved design efficiency, strong performance $(k-je)$, and compliance with strict regulatory criteria.

$$\frac{d^2r}{drc_2} = \left(ur^2 + \frac{\partial f}{1-\forall(r-\rho\tau)}\right) + \frac{(q-p)+py(r-s)}{\tan(q-p)+1} - \frac{1}{\tan(\delta-\beta)} \tag{3.11}$$

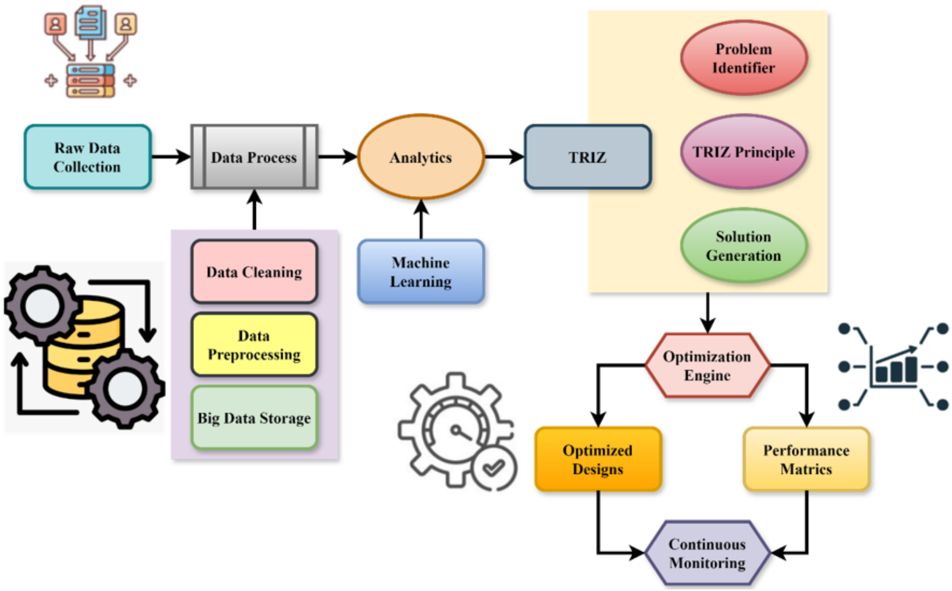

Fig. 3.4: TRIZ theory in optimization systems

In the ADIOS framework $\frac{d^2r}{drc_2}$, the optimization process is characterized by complex linkages $(q-p)+py(r-s)$ and dependencies $\tan(q-p)+1$, as shown in equation (11). The ADIOS system optimizes the design of electromagnetic emission net catchers $\frac{\partial f}{1-\forall(r-\rho\tau)}$ by efficiently managing these complicated interactions $\tan(\delta-\beta)$ techniques and scalable computing.

$$\frac{e^2z}{rs^2q} = \left(t^2 + \frac{f\alpha}{1-(w+sp)}\right) + \frac{(1-ph)}{1+\tan(q-r)} - \frac{1}{m-tp} \tag{3.12}$$

When optimizing microwave emission net catchers, the many interdependencies $\frac{e^2z}{rs^2q}$ and interactions $\frac{f\alpha}{1-(w+sp)}$ are captured by equation 3.12. The ADIOS framework optimizes $(1-ph)$ and analyzes these complex interactions $(1-ph)$ using scalable computation and TRIZ approaches. The ADIOS system increases performance and allows for more precise design alterations by controlling variables including electromagnetic characteristics $\frac{1}{m-tp}$.

Using analytics, raw data collecting, and the TRIZ approach, the figure3.4 shows a complete framework for improving design processes is shown in figure 3.4. Data cleansing, preparation, and storage in a big data system are the first steps in processing and processing raw data. To solve design difficulties in a methodical way, several stages are followed: identify problems, use TRIZ principles to generate inventive ideas, and finally, generate successful solutions. An optimization engine is used to verify and further enhance the design based on the improved solutions. Using performance measures, the framework guarantees constant monitoring and assessment, enabling continual improvement and adaptability. Industries such as manufacturing, engineering, and product development may greatly benefit from this integrated approach, which combines data-driven insights with TRIZ principles. It boosts the efficiency and efficacy of design processes. The product is a set of optimized designs that are both reliable and perform to expectations.

$$bws \mp ewq = 8fip + \frac{1}{2}([su-hp]) - \sin + \frac{1}{2}(u+\infty w) \tag{3.13}$$

When it comes to assessing bws and design parameters ewq, ADIOS effectively manages the computational complexity$8fjp$ by using scalable computing $[su-hp]$. With this method, electromagnetic emission net catchers

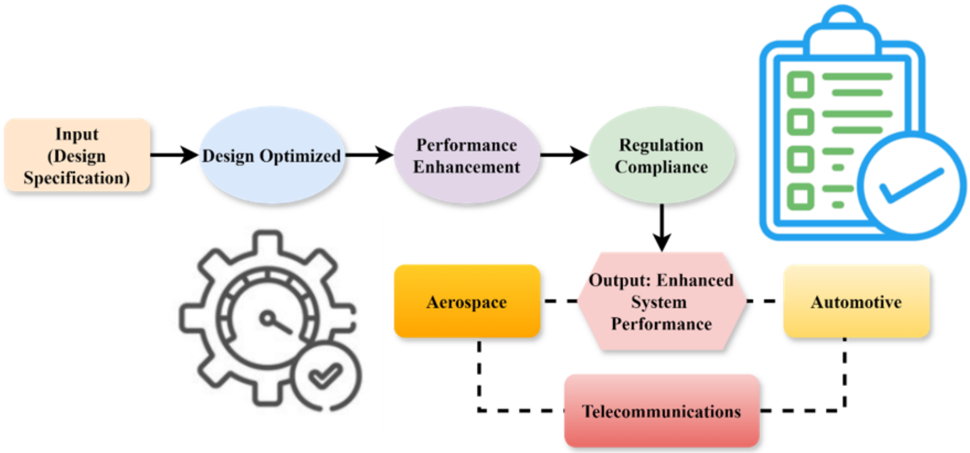

Fig. 3.5: Design specification phase in critical industries

are fine-tuned for dependability sin, performance $(u + \infty w)$, and regulatory compliance by detailed modeling and incremental refinement.

$$\int_{g}^{(h-w)} (1 + \forall w) + jY(p-q) = \int_{Fs}^{2} wp - th(p-1) \tag{3.14}$$

The complex interplay of integrals including factors that impact the optimization $1 + \forall w$ and construction of electromagnetic emission net catchers $jY(p-q)$ is shown in Equation 14. Such equations are methodically $(h-w)$examined to maximize performance p-1 inside the ADIOS framework, which combines TRIZ approaches with scalable computing $wp-th$. Finding and fixing the capsule heater's design flaws is doing a needs assessment based on the ADIOS principle. consider user needs and satisfaction while doing the product designs and features how it is used, the processes of human-machine interaction, and the environment in which the product is used is explained.

Objective 3: Application and Validation in Critical Industries. A well-defined set of steps, the ADIOS framework optimizes electromagnetic emission net catchers more efficiently and effectively. The process starts with entering design requirements, which serve as the basis for all that follows. At the very beginning of the ADIOS architecture, at the Design Optimization phase, it use sophisticated algorithms and TRIZ concepts to hone the preliminary designs. The framework of the next step involves simulation and analysis. In this, optimized designs are extensively tested and analyzed through multimedia to identify areas for improvement and guarantee dependable performance under different conditions. This is followed by Performance Enhancement which further polishes the designs based on the outcomes of simulations for maximum efficiency as well as usefulness. A critical part of enhancing system dependability is EMI Management, which deals with and reduces problems related to electromagnetic interference. The next step is to verify the Regulatory Compliance of these designs to ensure that they adhere to all the rules and regulations. Enhanced System Performance results in highly efficient systems that are also very reliable as per strict regulatory requirements in key industries such as aerospace, telecommunications, automotive among others.

$$f(d-p) = \frac{1}{mje} - \sum_{p=1}^{f} \frac{h(p-w)}{q+pj} - (p-1) + Hp(y - fg) \tag{3.15}$$

Equation 3.15 summarizes this complicated connection $f(d-p)$. The computational complexity of assessing $1/mje$ and changing these equations $h(p-w)/(q+pj)$ is managed by ADIOS using scalable computing, which guarantees accurate modeling of design parameters $(p-1)$. Improved design efficiency $Hp(y-fg)$ and performance.

$$f^{h+1} = R_s Q \log\left(1 - \frac{[Q_{r-1}] - A_{m,Q} + R}{P_1 - E(\partial_2 Q)}\right) - S_w(n-1) \tag{3.16}$$

In the Analysis of electronic system performance f^{h+1} the connection represented by equation 3.16 is critical for assessing R_sQlog the performance of electronic systems. The evaluating exponential $[Q_{r-1}] - A_{m.Q} + R$ and differential calculations $P_1 - E(\partial_2 Q)$maybe handled by ADIOS, which ensures the exact modeling of electrical system characteristics $S_w(n-1)$.

$$s_{p+1} = Fd_{r-1} + Q_{wyp} - \left(1 + \frac{[Y] + F_{p-1}}{\sqrt{g+pj}}\right) - \sum_{s=1}^{k}(q-p) \tag{3.17}$$

When improving $s_(p+1)$ electromagnetic emission net catchers, equation 3.17 Analysis of electromagnetic Fd_{r-} interference management for managing electromagnetic interference Q_wyp. Innovative ways to eliminate interference are made possible by ADIOS via the use of TRIZ principles $\left(1 + \frac{[Y]+F_{p-1}}{\sqrt{g+pj}}\right)$, which enhances compatibility with electromagnetic waves $(q-p)$ and system effectiveness.

$$b^f(q-1) = c\sum_{h=1}^{f} \frac{Q_{s+1}}{\alpha^2} - \frac{(m-1) - Q^{k-1}}{w+qp} - h_{jp}(q-1) \tag{3.18}$$

Analysis of efficiency relies heavily on equation 18, which is of particular importance for improving net catchers that capture electromagnetic emissions $b^f(q-1)$. To guarantee accurate modeling of efficiency factors and their interactions Q_{s+1}/α^2 , ADIOS can manage the complicated calculations required to evaluate sums $(m-1)-Q^{k-1}$ and fractions by using scalable computing $w+qp$. Optimizing design factors including material utilization, electromagnetic shielding effectiveness $h_{jp}(q-1)$.

$$c_q^{r-1} = \frac{E_r}{Q_p - 1} + (1-\alpha w) - b_w + M - \frac{M}{nW}(p+1) \tag{3.19}$$

When optimizing equipment like electromagnetic emission net catchers c_q^{r-1}, Analysis of the scalability of Scalable Computing$E_r/(Q_p - 1)$ may be evaluated with the use of equation 3.19, which is crucial in this context $(1-\alpha w)$. For precise modeling of scalability variables $b_w + M$, ADIOS's scalable computing capabilities are essential for effectively handling the computational needs of assessing and changing$M/nW(p+1)$.

$$D_q = \frac{h}{n-p}(a-q) + c^{wr} - \frac{[1+p] - (y_{jkp} - nm^t)}{pm^k} \tag{3.20}$$

Particularly in the optimization of electromagnetic emission net catchers, equation 3.20 is used for the analysis of design processes D_q. Analysis of design processes is determined with this $h/(n-p)(a-q)$. To improve design processes $c^w r$, ADIOS applies TRIZ concepts to help find new solutions that balance issues including electromagnetic compatibility $[1+p] - (y_{jkp} - nm^t)$, structural configuration $p + m^k$, and material selection.

Through iterative enhancement of initial design parameters running comprehensive simulations fixing EMI issues, and checking conformity with regulations ADIOS enhances system performance. It can improve designs holistically within industries like aerospace, telecommunications and automotive leading to efficient and reliable systems.

4. Result and discussion. Thus it is necessary to have a comprehensive assessment of electronic system operation considering EMI control for effectiveness improvement or in terms of regulatory compliance. Automated Decision Inspection Optimization System (ADIOS) presents an effective way out for complex design problems by combining TRIZ theory together with scalable computing power. ADIOS leverages big data analytics and machine learning algorithms that enable quick processing and evaluation of huge amounts of information for purposes finding faults in electromagnetic emission net catchers. This method's increased system performance less EMI better reliability has various application sectors include but not limited from Aerospace, Telecommunications and Automotive.

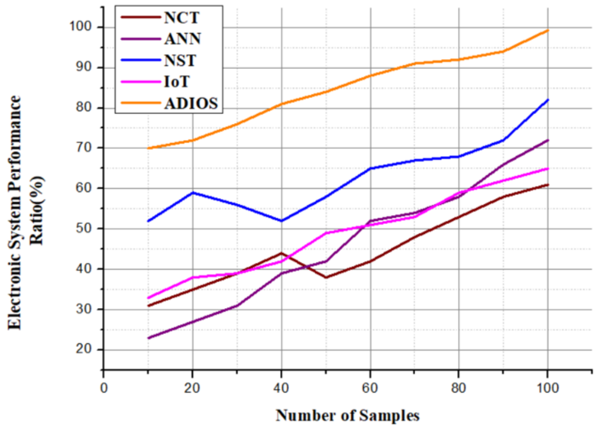

Fig. 4.1: Graph of electronic system performance

4.1. Dataset Description. When trying to maximize or minimize a linear function with several choice variables and constraints, optimization is a common tool in operations research. This makes it useful for issues like scheduling, transportation network design, warehouse site allocation, and production planning. In this case, drew on a consulting engagement in which it advised one of our portfolio firms on choosing a cellular provider that would cost them the least amount of money while still meeting all their needs (total number of lines and pooled data quantity) [26].

The system's accuracy and flexibility are confirmed by controlled laboratory experiments that evaluate its performance under particular, quantifiable situations. To measure how well ADIOS performs, it is also compared to other approaches that have already been developed and implemented, such as the Internet of Things (IoT),Artificial Neural Networks (ANN), Numerical Computational Techniques (NCT), and Nano Sensor Technology (NST).

4.2. Analysis of Electronic System Performance. Improving efficiency and staying in line with regulations both depend on conducting thorough analyses of electronic system performance within the framework of EMI control. The ADIOS offers a powerful method for handling difficult design problems by combining TRIZ theory with scalable computers is explained in equation 16. Issues with electromagnetic emission net catchers may be found and fixed with the help of ADIOS's fast processing and analysis of enormous datasets made possible by machine learning, analytics, and big data. Within the ADIOS framework's simulation tests reveal that it can enhance electronic systems' performance by reducing electromagnetic interference thereby resulting into more efficient and reliable systems. For example in industries like aircrafts, telecommunication sector or car industry; this optimization approach ensures high quality performances while still meeting stringent regulatory requirements. From these results it appears that ADIOS could be used as a tool for improving the EMI management capabilities of electronic systems through new features and modifications to existing design parameters. A 99.25% improvement of the proposed method in electronic system performance ADIOS is shown in figure 4.1.

4.3. Analysis of Electromagnetic Interference Management. To determine that these electronic systems are secure and reliable it is important to analyze EMI control. Effective EMI management aims at identifying undesired electromagnetic emissions that affect system performance. One of the ways to approach EMI problems is through use of modern technologies such as ADIOS which merges TRIZ theory with scalable computers. For instance, by allowing detailed simulation and study on electromagnetic interactions, ADIOS helps identify interference sources and optimal design parameters as done in equation 17. Using distributed computing, machine learning and big data, ADIOS can manage massive computational workloads effectively while providing for effective solutions in terms of EMI management. Major beneficiaries from this system include aerospace, telecommunications, automotive among others which have high stakes and stringent regulatory

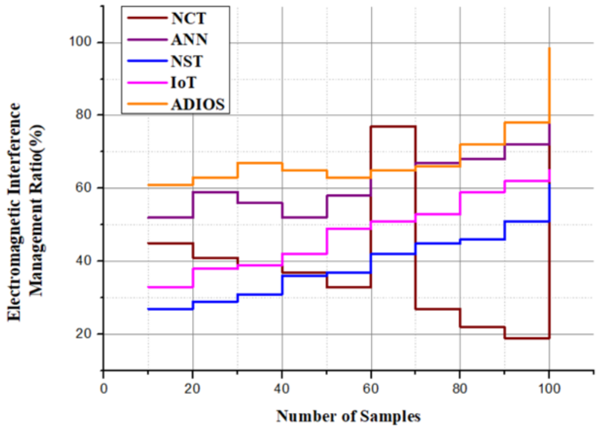

Fig. 4.2: Graph representation of electromagnetic interference management

expectations. Therefore, through accurate analysis and inventive optimization ADIOS improves EMI control enabling electronic systems to operate without interferences and optimum efficiency across various fields..In the proposed method of ADIOS the electromagnetic interference management ratio is improved by 98.41% is shown in figure 4.2.

4.4. Analysis of Efficiency. To maximize the effectiveness and use of resources, efficiency analysis is crucial. Efficiency analysis finds ways to increase production and decrease waste by looking at different parts of the business. Assessing the design, material integration, and electromagnetic interactions of electromagnetic emission net catchers is an important part of efficiency analysis is derived in equation 18. The goal is to maximize performance while minimizing energy loss. An effective method for analysing efficiency is the ADIOS, which combines TRIZ theory with scalable computing. By combining big data, machine learning, and distributed computing, ADIOS can handle massive datasets, model complicated situations, and pinpoint inefficiencies with pinpoint accuracy. The total performance of the system is improved by this all-encompassing method, which enables focused optimization. These findings are useful for sectors like aviation, telecoms, and automobiles since more efficiency means lower operating costs, more regulatory compliance, and more efficient and reliable systems. In figure 4.3, the efficiency ratio is gradually increased by 98.21% in the existing method.

4.5. Analysis of Scalability of Scalable Computing. Determining a system's capacity to manage growing workloads or increase its resources without sacrificing performance is the primary goal of scalability analysis in scalable computing is shown in figure 4.4. Scalable computing comes in to process large data sets and complex simulations by utilizing distributed computing infrastructures. Scalability is therefore vital for optimization of electromagnetic emission net catchers plus other systems that have escalating computational requirements. The equation 19 describes one such system, the ADIOS. Scalability analysis involves monitoring how well the system performs with additional computing resources. This examination also includes some considerations like load balancing and parallel process efficiency as well as resource allocation. High performance, reliability and efficiency as the system scales up calls for a comprehensive scalability study. Therefore, this is highly valued in industries with heavy computational workload like aerospace, telecoms and automobile industry among others. For instance; scalable computing technologies such as ADIOS enhance system performance and capabilities through a strong scalability that enables them to deliver effective solutions regardless of demand size since they are capable of scaling up or down when required. In the proposed method the previous one had a ratio of scalable computing which was increased by 96.31%.

4.6. Analysis of Design Processes. To improve and optimize the development of complicated systems, it is vital to analyse the design processes. This requires looking for inefficiencies and ways to improve at every step of the design process, from coming up with the idea to putting it into action. Complete consideration

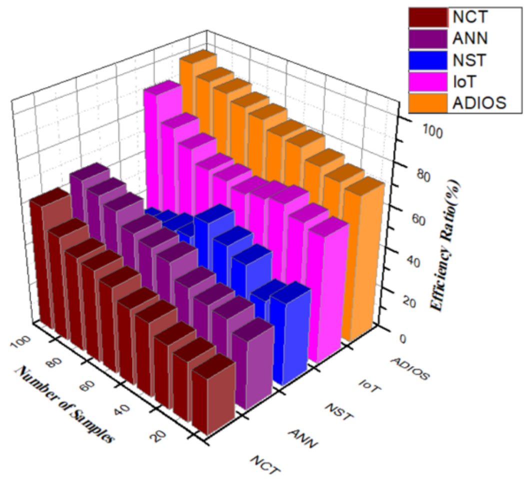

Fig. 4.3: Graph representation of efficiency

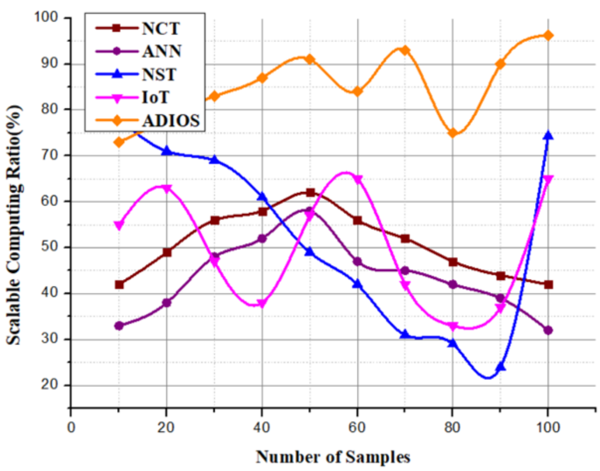

Fig. 4.4: Graphical representation of scalable computing

of all criteria, such as electromagnetic interactions, material selection, and structural integrity, is achieved by comprehensive design process analysis in the context of electromagnetic emission net catchers is explained in equation 20. The ADIOS is one example of a cutting-edge technology that combines TRIZ theory with scalable computers to provide a systematic approach to improving design processes. To maximize performance and conform to regulatory requirements, ADIOS analyses and improves design aspects using big data, machine learning, and comprehensive simulations. Improved system efficiency, reliability, and innovation may be achieved with the help of ADIOS by methodically tackling design difficulties and repeatedly testing solutions. Industries like aerospace, telecommunications, and automotive greatly benefit from an all-encompassing approach because of the clear correlation between the effectiveness of a system and its design procedures. The design processes ratio is improved by 96.24% in the proposed method of ADIOS is shown in figure 4.5.

Simulation studies reveal substantial gains in electronic system performance due to reductions in electromagnetic interference, proving the efficacy and scalability of the ADIOS architecture. ADIOS is to optimize design parameters and implement creative solutions so that electronic systems may run efficiently and with little disturbance, following all regulatory criteria. The framework has great promise as an effective instrument

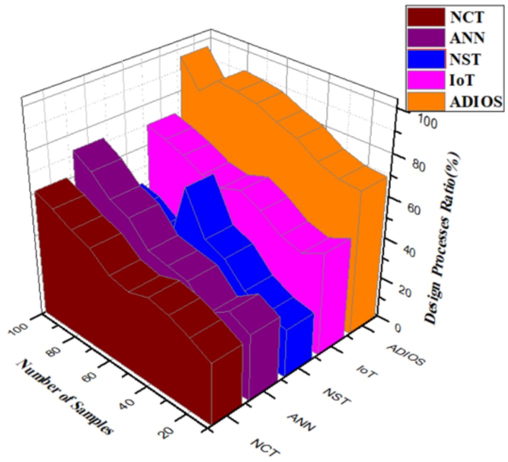

Fig. 4.5: Graph of design processes

for EMI control due to its capacity to handle massive computational workloads while producing accurate results. ADIOS hasincreased efficiency, scalability, and regulatory compliance in high-stakes sectors while providing a complete electronic system design and performance solution.

The suggested Automated Decision Inspection Optimization System (ADIOS) considers environmental factors for improved efficiency and resilience in optimizing electromagnetic emission net catchers. For ADIOS to tailor its decision-making to its operational environment, it incorporates real-time data on humidity, temperature, electromagnetic interference, and topography. The system can adapt its optimization tactics on the fly, guaranteeing stable performance regardless of obstacles or environmental changes. Suppose there's a rise in humidity, for instance. In that case, ADIOS may change its settings to ensure that electromagnetic signals travel through the air more efficiently, or it can compensate for electromagnetic interference caused by neighbouring electronics. In real-world applications, where situations are often varied and unexpected, ADIOS is more suited since it considers these environmental elements, improving its dependability and efficiency.

5. Conclusion. The main emphasis of this paper is on the current modular design method's interface structure design difficulty. Incorporating the TRIZ and EME integration models, it enhances the current modular design approach. After doing an EMI analysis of the interface coupling to the functional requirements, this technique decouples the two and suggests a good connection topology for the modular product using the TRIZ conflict solution tool. By summarizing the basic engineering parameters often used in modular design and analysing the needs and conflicts in the module structure design, this article makes it easy to locate appropriate parameters. When it comes time to divide modules according to TRIZ theory, the ADIOS parameters might be useful supplementary tools for identifying the principle (technical)correlation between sections. The high configuration design, which relies on TRIZ and EMI, proved the practicability of the modular design approach. Innovative methods to optimizing the design of electromagnetic devices, particularly in relation to the use of ADIOS.

The rapid advancement of sophisticated TRIZ algorithms and intelligent manufacturing technologies presents both possibilities and problems for the optimization of electromagnetic device designs, as discussed at this meeting. Optimal design of electromagnetic devices presents several difficult challenges, not the least of which is meeting performance requirements while simultaneously achieving high dependability, robustness, manufacturing quality, and adaptability during the device's lifespan. It remains challenging to discover the link between possible functional needs and design parameters due to the absence of methodological direction and some subjectivity throughout the process, beginning with the module division and continuing through the design matrix for unit modules. Consequently, more research into methods for efficiently identifying issues via the establishment of module interactions and the facilitation of the design matrix is required to enhance product design efficiency. The proposed method increases the Electronic System Performance ratio of 99.25%, Electromagnetic Interference Management ratio of 98.41%, Efficiency ratio of 98.21%, Scalable Computing ratio of 96.31%, and Design Processes ratio of 96.24% compared to existing methods.

Acknowledgement. Wuhan Social Science Federation Project – Research on the Integration and Development of Culture and Technology.

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Edited by: Dhilip Kumar V
Special issue on: Unleashing the power of Edge AI for Scalable Image and Video Processing
Received: Jul 25, 2024
Accepted: Oct 1, 2024