Scalable Computing: Practice and Experience, ISSN 1895-1767, http://www.scpe.org
© 2025 SCPE. Volume 26, Issues 4, pp. 1577–1590, DOI 10.12694/scpe.v26i4.4430

RESEARCH ON DESIGN AND OPTIMIZATION OF ELECTROMAGNETIC THROWER BASED ON KJ-AHP COMPREHENSIVE DECISION METHOD USING SCALABLE COMPUTING

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

Abstract. The research delves into electromagnetic thrower optimization and design by using KJ-AHP full decision method, augmented by scalable computational techniques. In many industrial contexts, electromagnetic thrusters play an important role, especially in propulsion and material handling functional systems. Mechanical limits, nonlinear electromagnetic interactions, thermal consequences, and their apparent promise for such factors. By integrating innovative decision-making methods, the primary objective is to develop a systematic approach that addresses the key challenges in electromagnetic thrower design, such as mechanical constraints, non-linear electromagnetic interactions, and thermal effects. The research integrates the KJ (Kawakita Jiro) method and proposes a new approach to solve these problems in creative problems solution using the AHP (Analytic Hierarchy Process) method of decision making. Scalable computing allows us to efficiently manage the large amount of computational resources needed for optimization and simulation. Achieving the right balance of productivity and performance is achieved through an integrated approach, which enables comprehensive analysis of design aspects. Through a comprehensive study, it has been demonstrated that the proposed method is efficient, indicating high efficiency and accuracy of the electromagnetic impeller systems. These findings suggest that the method can be used to improve the efficiency of electrical power systems designed for scientific and industrial purposes. The results provide light on how to put scalable computing and advanced decision-making frameworks into practice for engineering optimisation. The analyses reveal that scalable computing enhances optimization efficiency by 96.3%, overall efficiency by 96.8%, accuracy by 97.52%, integration for decision making by 98.15%, and performance evaluation of electromagnetic throwers by 98.16%.

Key words: Design, Optimization, Electromagnetic, Thrower, Comprehensive, Decision, Scalable Computing, Analytic, Hierarchy Process

1. Introduction.

Electromagnetic throwers have become indispensable in industrial applications due to being able to efficiently and accurately implement systems that need high reliability and precision [1]. Designing and optimizing such systems is very challenging since there is the complex interaction between mechanical constraints, non-linear electromagnetic interactions, and thermal consequences [2]. It is possible to classify these problems into three groups. To tackle these problems, it's necessary to use advanced methods that can thoroughly evaluate and optimize various design elements simultaneously [3]. This paper delves into a novel method for designing and optimizing electromagnetic throwers by using the KJ (Kawakita Jiro) methodology and the AHP (Analytic Hierarchy Process) inside a scalable computer system [4]. This means improving the electromagnetic insulation and it is considered as a creative approach in problem solving with the help of KJ techniques or more often AHP (Analytic Hierarchy Process) [5]. It takes a research and an artistic approach at the same time and this interactive partnership allows for a more thorough consideration of policy options [6]. Then relies heavily on scalable computing, which is used to process large amounts of data needed to optimize and simulate electromagnetic systems [7]. Scalable computing abandons the optimization process because many computing tasks are distributed over many processors efficiently though availability of materials plays an effective role [8]. It can also consider complex dynamics at networks also as thermal effects [9]. In a scalable computing environment, these two methods (KJ method and AHP) form a solid basis for theoretical handling of design variables and there is great opportunity if such a combination strategy is used exist to create more efficient and effective EM interceptors [10]. Extensive simulation tests on electromagnetic impeller designs prove

*School of Industrial Design, Hubei University of Technology, Wuhan, Hubei, 430022, China (Corresponding Author, 15927010701@163.com)
†School of Industrial Design, Hubei University of Technology, Wuhan, Hubei, 430022, China (lwy20240606@163.com)
‡School of Industrial Design, Hubei University of Technology, Wuhan, Hubei, 430022, China (sanstxu@163.com)

effective as they significantly improve performance and accuracy [11]. The implications of this paper extend beyond specialized application areas such as EM missiles but provide some insight into technological progress in general [12]. The results also suggest that technological problems can be solved within addresses difficulty by combining scalable computing with complex decision-making algorithms [13]. By balancing many design features, including magnetic field strength, coil arrangement, and power consumption, the research addresses issues in building these systems for greater efficiency, performance, and energy usage. The study uses scalable computing to optimize and analyze data more efficiently, which speeds up and reduces the cost of development. This is important for both academic and industrial purposes.

This integrated approach has potential utility across several scientific and industrial sectors thereby streamlining design procedures and enabling high performance system development [14]. This paper closely examines one innovative way of designing optimized electromagnetic throwers'. It also highlights the synergy between scalable computing and KJ-AHP methods among others things [15]. The results indicate that the mentioned method improves efficiency and performance of EMS, while revealing some interesting trends regarding how engineering optimization may develop in future.

The contribution of this paper:

1. *Design Process of KJ-AHP:* A scalable computational framework should integrate the KJ approach with the AHP technique to give a breakthrough methodology for developing and optimizing the design of electromagnetic throwers
2. *Implementation of KJ-AHP:* Highlighting the broader implications of this method for engineering optimization is crucial, as it demonstrates its ability to streamline design processes and enhance the performance of high-precision systems across many scientific and industrial domains.
3. *Evaluation of Performance metrics:* Significant simulation experiments are necessary to prove that this integrated approach works. These experiments are expected to show that electromagnetic thrower systems are far more efficient and accurate.

In this paper, Section 2 denotes the various methods used in the Electromagnetic Thrower for design an optimization. Section 4 denotes the through extensive simulations, the approach demonstrates significant improvements in optimization efficiency, accuracy, and overall performance. Section 5 describes the results indicate that the method can enhance the development of high-performance electromagnetic systems for industrial applications, offering substantial benefits in precision, reliability, and efficiency.

2. Related work. The paper takes a look at how electromagnetic launch systems have evolved recently, specifically at the QEED. Using construction, finite element analysis, and electromagnetic modeling as focal points, an empirical comparison is conducted using four-track launch systems. To be able to make accurate predictions regarding the projectile's velocity, the ANFIS optimizes the launcher parameters. A new design for electromagnetic weft insertion in looms is also suggested in the findings, and the analysis also looks at cost-effective electromagnet designs and other objectives optimization of launcher coils.

Quad-pole Electromagnetic Ejection Device (QEED). One of the factors taken into account is linear motion, which has several uses although is especially important at the launch zone. Some curious kinds that are now being considered are a coil launcher and an electromagnetic launcher with two tracks. Aircraft technology specialists are currently keeping tabs on the idea of a four-track electromagnetic launcher. A simple device called the QEED is designed and built in the present analysis [16]. An empirical comparison is established between the quad-pole and four-track electromagnetic launch systems. In along with outlining the realistic needs for electromagnetic space launch technology, this paper details the steps needed to build a basic quad-pole electromagnetic launch device, conduct finite element analysis, model electromagnetic and current properties, and observe the skin effect and proximity effect of the current clearly. Particle Swarm Optimization is used to get the best possible design of the QEED.

Adaptive Neuro Fuzzy Interface System (ANFIS). An electromagnetic launcher may be used as an accelerator to speed up the fiber that is connected to the ferromagnetic projectile. For the purpose of to optimize the object's speed in this novel weave insertion, it is recommended that several states of launcher parameters be used to obtain the projectile velocity. Conducting experimental investigations requires a substantial investment of both time and money. Consequently, the ANFIS, a proven model, was used to accurately predict the projectile's velocity [17]. Compared to experiments, this model can anticipate the system's behavior with more accuracy and speed. By finding the optimal values for the launcher parameters, the optimization result of the genetic algorithm shows that this weft insertion approach may reach the speed of contemporary weaving machines. The ANFIS model provides an additional useful avenue for obtaining the system's output. Using this approach, the system may be enhanced to fulfill the needs of extra desired objectives.

Electromagnetic Weft Insertion Methods (EWIM). The paper aims to address the problem of extra-large width automated looms' subpar performance in electromagnetic weft insertion acceleration. An electromagnetic weft insertion design plan for a sectional combination of continuous acceleration is proposed. Both the single-stage and multi-stage intermittent EWIM form the basis of this design strategy [18]. An innovative weft gripper for electromagnetic weft insertion is initially built using the traditional projectile as a foundation. Further, the 90 mm single-stage coil undergoes an optimization design based on a segmented combination structure. The building is optimized by using both of these ideas. The following phase is to build the electromagnetic weft insertion movement model so that we can analyze the gripper's force and movement speed as it moves.

Multi-Variation Modeling for EML Selection. The field of electromagnetics has not been omitted from the worldwide trend of developing high-functioning techniques, especially in electrical and electronic engineering. The paper reports the outcomes of simulating several variations of a single magnet with the aim to assess the force versus current criteria. This is why an electromagnet with a standard design that works with the EML has been chosen [19]. After the modeling was finished, the theoretical estimates were also checked, and finally, the application's feasibility and cost were evaluated. It utilize the ANSYS 2D electromagnetic suite for all of our modeling and design needs. It has been found that this method is efficient and cost-effective while producing the force essential for launch candidacies.

Genetic Algorithm (GA). The technical goal of the ultra-wide electromagnetic launch weft insertion technology is to provide a constant electromagnetic force as large as possible. The electromagnetic force acting on the weft gripper grows in direct correlation with the gradient value of the magnetic field strength. This paper explains a method for optimizing the coil structure [20]. It can improve the acceleration of the weft clamp by optimizing the aspect ratio of the coil and arranging the number of turns of the coil. A mathematical model for electromagnetic force computation based on ferromagnetic materials' nonlinear features is established, and multi-objective optimization is performed using a GA. Results show that optimized coil outperforms non-optimal coils in terms of emission performance and electromagnetic force work.

This paper compares and contrasts four-track systems with the QEED. The ANFIS is used to enhance the launcher's settings for a more precise forecast of projectile velocity. An innovative method is introduced for incorporating electromagnetic weft into automated looms, leading to enhanced performance. Efficient and efficient creation of magnetic designs at low cost is the subject of analysis, along with multi-objective optimization of launcher coils. Significant progress seems to have been made in both force production and system behavior prediction.

Based on the survey, there are several challenges with existing models in achieving high accuracy, efficiency, performance, and decision-making. The research integrates the KJ (Kawakita Jiro) method and proposes a new approach to solving these problems in creative problems solution using the AHP (Analytic Hierarchy Process) method of decision-making.

3. Proposed method. The use of advanced modeling and analytical tools is essential for the prediction of thermal effects in the field of electromagnetic system optimization and design. To optimize designs, integrate scalable computing technologies for efficient management of complicated simulations and massive datasets, and so on, the KJ-AHP decision process is crucial. Before optimizing designs for industrial applications, they undergo rigorous testing to guarantee accuracy and dependability. This improves performance and efficiency. In this all-encompassing method, electromagnetic modeling and thorough testing serve as guides for iterative parameter tuning and structure optimization with the goal of maximizing voltage and power outputs. This approach targets scientific and industrial problems with answers that are both technically excellent and environmentally and practically sound.

Combining the KJ (Kawakita Jiro) and AHP (Analytic Hierarchy Process) approaches, the KJ-AHP technique handles the electromagnetic thrower design concerns methodically. When solving important problems, including mechanical restrictions, non-linear electromagnetic interactions, or thermal impacts, the KJ technique may be utilized to creatively arrange and structure various thoughts and insights. By prioritizing different design

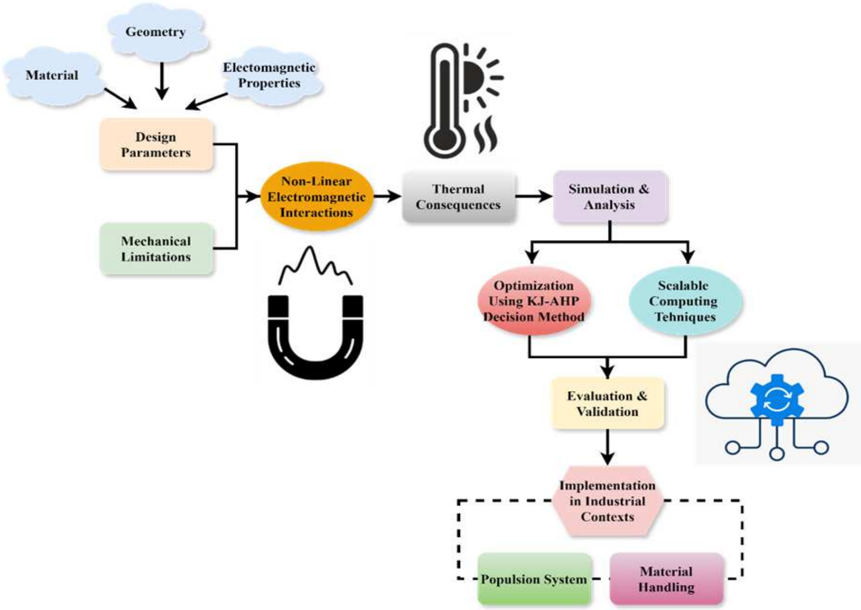

Fig. 3.1: Electromagnetic Thrower Based on KJ-AHP

elements according to their influence and significance, the AHP technique allows for a quantitative decision-making process after these challenges have been specified. By combining these different aspects, this study can assess the whole picture while still weighing the relative importance of variables like performance, efficiency, and cost. With scalable computers, the KJ-AHP approach can quickly handle large data sets, allowing for accurate optimization and modelling of electromagnetic thrower designs. This, in turn, improves their efficiency, reliability, and accuracy.

3.1. Contribution 1: Design process of KJ-AHP. About thermal repercussions and practical application, shows a complete approach for improving electromagnetic systems. Design parameters, such as material choice, shape, electromagnetic characteristics, and mechanical constraints, are defined first. Careful consideration is required of the thermal ramifications caused by these factors' effects on non-linear electromagnetic interactions.

To effectively predict these thermal impacts, simulation and analytic technologies are used. To optimize the design for better performance, the KJ-AHP decision process is used. Next, scalable computing methods are used to effectively manage intricate simulations and massive data sets. The findings are thoroughly tested and verified to guarantee their correctness and dependability. Industrial settings, including population systems and material handling, may then make use of the proven optimum designs. This is the last stage in making sure that all that hard work in theoretical models and simulations pays off in the form of improved performance and efficiency in the actual world. The overarching goal of the process is to provide cutting-edge solutions for electromagnetic system design and optimization by combining cutting-edge computational methodologies with real-world industrial requirements is shown in Fig.3.1.

$$f^e_{h-j} = E_k Flog(1 + \frac{([j_{l,T}] * Z_{s,T} + j_{-p}}{(d_2(1 + sp)}) - S_{t+1}(uf - q) \tag{3.1}$$

The Equ.3.1 captures the optimization of the electromagnetic thrower f^e_{h-j}, which incorporates the interaction of many components. Equation E_k Flog shows how well the decision-making process balances effectiveness $Z_{s,T}$ with effectiveness $[j_{l,T}]$ to the KJ-AHP technique j_{-p}. By handling complicated simulations $d_2(1 + sp)$

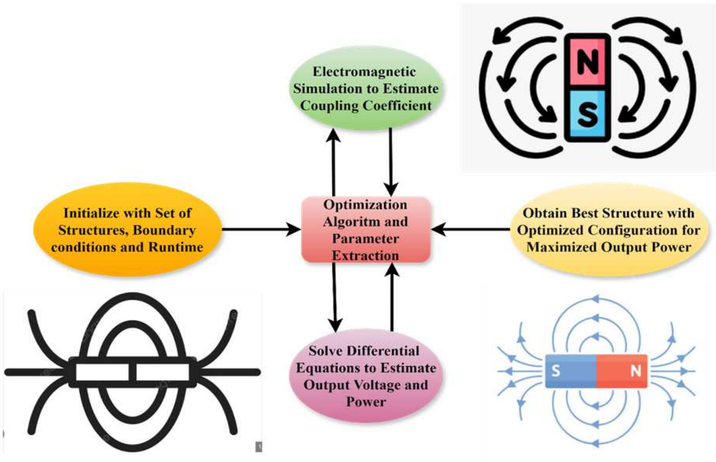

Fig. 3.2: Diagram of Electromagnetic Thrower

and big datasets S_{t+1}, scalable computing enhances this optimization uf-q, leading to far better design results.

$$f_q^{np} = \alpha N_{p-q} + R_{sq}(n+1) - (1 + ([M] + w_e f)/(\sqrt{XD} + E^f) + \sum_{k=1}^{l}(m+np) \tag{3.2}$$

The electromagnetic thrower's complex internal force balance f_q^{np} is shown by Equ.3.2. To improve the system's efficiency αN_{p-q} and accuracy $R_{sq}(n+1)$, this equation uses the KJ-AHP holistic decision approach [M]+ w_e f to emphasize the complicated optimization that is necessary $\sqrt{XD} + E^f$. With scalable computing (m+np), massive computational needs may be handled with ease, allowing for accurate parameters.

$$a_{f-1}^v = \sum_{k=1}^{b} \frac{r_s}{(s_f+1)} + \frac{Q_{k+1}, T}{d^2} + \frac{(1+p) + F_{m+1}}{\alpha + 4} \tag{3.3}$$

The optimal design a_{f-1}^v of the electric thrower is affected by several elements, which are shown by Equ.3.3. Equ.3.3 highlights the systematic examination of the influence of each parameter $\frac{r_s}{s_f+1}$ on system performance using the KJ-AHP complete decision approach. For a reliable $\frac{[Q_{k+1},T]}{d^2}$ and precise optimization d^2, scalable computing is essential, as it allows for the complicated computations $(1+p) + F_{m+1}$ and simulations that are necessary $\alpha + 4$.

$$a_{m+1}^l = \frac{(1+p) - T^(f+1)}{\forall + 4} + \sum_{h=Q}^{S}(1+\forall) - (\sum_{p}^{1}(s+f)) \tag{3.4}$$

The optimization of the electromagnetic thrower a_{m+1}^l is captured by the Equ.3.4, which takes into account T^{f+1} the dynamic exchanges and trade-offs $\forall + 4$. This equation shows the systematic way to evaluate the impact of each component on the system's performance $\sum_p^1(s+f)$. It is derived from the KJ-AHP complete decision procedure.

$$b_{f+p}(m+n) = \frac{D_{w+1}}{Q_f} + (1+Sp) * H_f + \frac{F^(m+1) + (l+p)}{3+d} \tag{3.5}$$

Fig.3.2 shows a procedure for improving electromagnetic systems so that their voltage and power outputs are maximized. Defining a collection of structures, boundary conditions, and runtime settings is the first step in initializing the system. All future simulations and analysis build upon this baseline configuration. The coupling coefficient, an essential parameter for describing the interaction between components of a system and magnetic fields, is then estimated via electromagnetic modeling. Here, we represent the magnetic flux and field lines in great detail. To fine-tune the system setup, the process uses optimization methods and parameter extraction techniques after the simulation. Finding the optimal structure that produces the most efficient and powerful output is the main objective. Iteratively testing different setups and recording their results is part of this process. The system's estimated output voltage and power are determined by solving differential equations using the optimized structure. Various aspects affecting the electromagnetic thrower's performance $b_{f+p}(m+n)$ are included in the equation 5. By methodically evaluating these aspects $\frac{D_{w+1}}{Q_f}$, the KJ-AHP complete decision approach guarantees balanced optimization (1+Sp). Because of scalable computing, large datasets and complicated simulations may be handled more efficiently and accurately $\frac{(F^{m+1}+(l+p)}{(3+d)}$.

$$C_h = \frac{f}{n+pj}(p-z) + a_{er} - \frac{[w_{fg+1}^2 - e]}{q}dr \tag{3.6}$$

A part of the electric thrower system is interdependent C_h, and this is reflected in the Equ.3.6. This equation demonstrates how the KJ-AHP holistic decision approach takes into account the impact of each parameter on the system's efficiency in a systematic way $\frac{f}{(n+pj)}$. As a way to manage the computational complexity a_{er} and enable efficient $[w_{fg+1}^2 - e]$ and accurate optimization q, scalable computing is essential dr.

$$H_{j+f} = s^f - \frac{m}{e+f}(ky - fp) + zwe^{f+1} - \frac{4s(q^{w+1})}{s} \tag{3.7}$$

Several factors influence the optimal functioning of the magnetic thrower H_{j+f}, and this Equ.3.7 shows how these factors interact with one another s^f. With the use of the KJ-AHP comprehensive selection approach $\frac{m}{e+f}$, this equation shows (ky-fp) the impact of each element on performance is evaluated methodically zwe^{f+1}. With scalable computing, processing needs may be easily met, leading to optimization $\frac{4s(q^{w+1})}{s}$ that is both accurate and efficient.

$$l_f(nq+p) - (w+1) = (m+hy) - aw^{f+jyg} - 8_f(n+pk) \tag{3.8}$$

The best possible performance of an electrical thrower involves capturing the numerous interactions between many parameters $l_f(nq+p)$. The equation does just that (w+1). To make sure that every factor's effect on system performance is thoroughly examined (m+hy), the KJ-AHP thorough decision approach methodically assesses these interdependencies. Accurate simulations and analyses need $8_f(n+pk)$ computational resources, which scalable computing helps to manage.

$$f_{w+ne} = t + 1\sum_{k=1}^{2} M_e(1-dq) + (s_{w-1}) \tag{3.9}$$

Equ.3.9 shows several factors that affect the optimization of the electromagnetic thrower f_{w+ne} when used together. To make sure these characteristics are thoroughly evaluated and their impacts on system performance are balanced $M_e(1-dq)$, the KJ-AHP comprehensive selection approach is used (s_{w-1}). In summing up stage five marks finalization stage where the theoretical design becomes practical resulting into good outcomes. By doing so, it presents a solid workflow for improving electromagnetic systems, thereby increasing their efficiency and productivity in practical applications. This methodical process is imperative when developing current electrical devices that would work efficiently in an industry..

3.2. Contribution 2: Implementation of KJ-AHP. An accurate and appropriate analysis can only be done after the issue space has been defined and the design criteria and constraints have been established. KJ-AHP integration enables prioritization and optimization of these design parameters. This technology utilizes scalable computing methods to efficiently handle large datasets and complicated simulations..

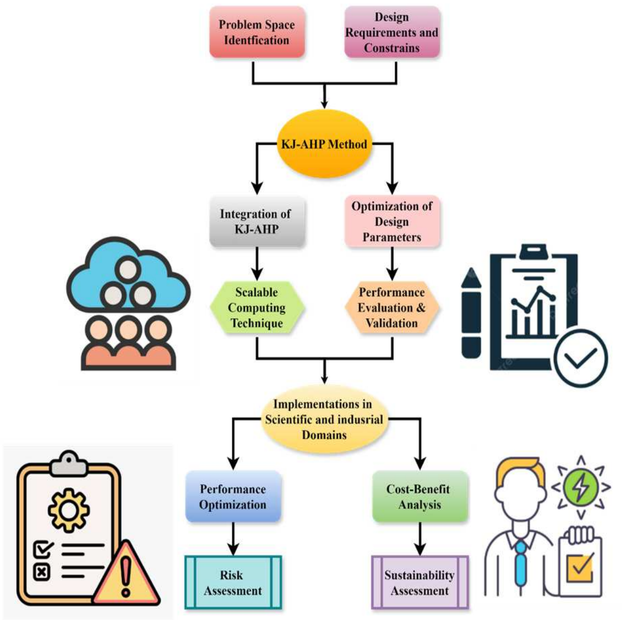

Fig. 3.3: The Block Diagram of KJ-AHP

In Fig.3.3, outlines a structured method for using the KJ-AHP technique in optimizing design parameters within scientific and industrial environments. Afterwards, they are tested and evaluated to ensure that they are reliable as well as effective. Once these minimalistic designs are confirmed, they are used in various applications in science and industry. In this stage, one optimizes performance to make it as efficient as possible, assesses risks to find problems and evaluates gains to see if it is financially viable. Sustainability assessments are carried out also so that the designs can be applicable for long-term as well as short-term cases. That's why the approach combines strong technical performance with practical application and sustainability balance of an efficient solution. This would mean finding a middle ground between technical performance, practical application, and sustainability thereby allowing for creating strong yet efficient solutions. Fitting KJ-AHP results in scientific/industrial set-ups will ensure a focused and organized optimization process that brings about improved outcomes.

$$minA = \sum_{k=1}^{Q}(E^{e}_{s+P} - z_{q+p}) + \sum_{k=1}^{fd} Q^{p}_{w+1} + Z_{wd}(p_2 - 1(mn)) \tag{3.10}$$

The balance between energy usage $E^{e}_{s+P} - z_{q+p}$ and other indicators of success are captured by the equation, which optimizes the electromagnetic thrower $Q^{p}_{w+1} + Z_{wd}$. In its pursuit of optimum design, the KJ-AHP complete decision process methodically assesses these many criteria $p_2 - 1(mn)$.

$$Q_2 + (S, f) : \sum_{k=1}^{r} m_f + h_3(1 + jp) + \sum_{H_q - p}^{n} f_{m_n} + s_{ew} \tag{3.11}$$

The optimization of the electromagnetic thrower is affected by a web of interdependencies and complicated interactions, detailed in Equ.3.11. Using the KJ-AHP complete decision approach (S,f). The cognitive intensity of analyzing various scenarios m_f and variables $h_3(1+jp)$ must be managed using scalable computing to ensure exact optimization. The improved design of the electromagnetic thrower is the result of this integrated approach

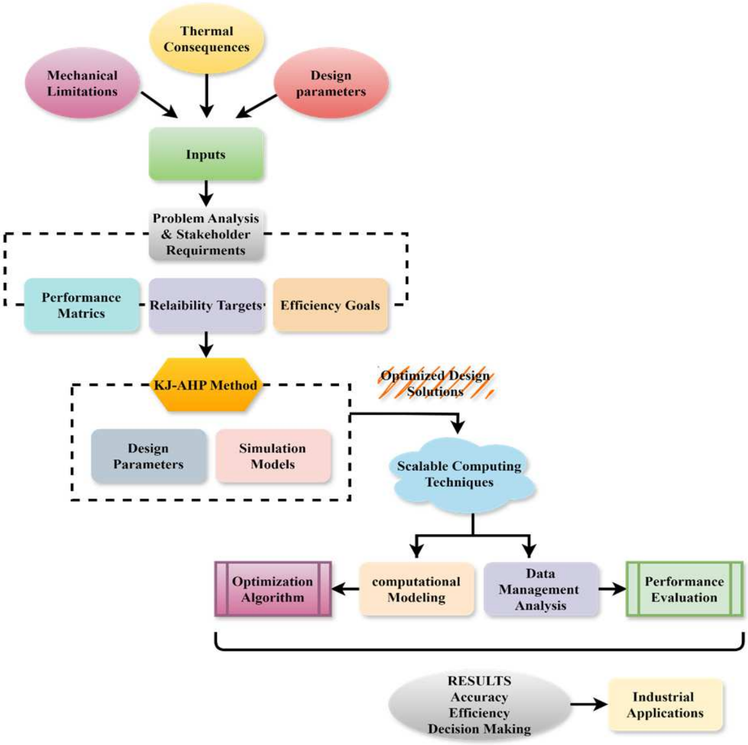

Fig. 3.4: KJ-AHP Comprehensive Decision Method using scalable computing

$f_{m_n} + s_{ew}$, which increases its utility and efficacy in a wide range of operating settings.

$$\sum_{l<Q}^{q} \forall k_{1-p} < 1 + \sum_{s=1}^{r} (pq) + (1 - q(hj + s)) \tag{3.12}$$

The tuning of the electric thrower was impacted by a complete assessment $\forall k_{1-p}$, which is reflected in Equ.3.12. Each parameter's impact on system productivity and reliability is taken into account by this equation (pq), which stresses a systematic approach to decision-making using the KJ-AHP technique 1-q(hj+s).

The first step is issue analysis and needs gathering. This stage should provide an understanding of heat consequences and define aspects such as performance measurements; objectives for reliability; efficiency targets; and accuracy requirements. To create a broad overview of the problem area, relevant literature was reviewed alongside conducting stakeholder need identification exercise. The KJ-AHP approach is employed to enable decision making processes and foster problem solving skills among users. Models and simulations using predetermined criteria sub-criteria against prospective design options are used under this strategy. It checks whether the stated needs match up with optimum designs. Scalable computing strategies which employ high-performance computing, cloud platforms and distributed computing resources are used to handle computational requirements.The presence of these computer facilities enables data optimization algorithms that facilitate management plus evaluation.

$$\sum_{T+1}^{f} S_q(p + df) < 1 - \sum_{q=p}^{n} (1 + f^2 wd) + S_(w - 1) \tag{3.13}$$

The complex interplay of variables impacting an electromagnetic thrower's optimization is captured $S_q(p + df)$ in the Equ.3.13. This equation is a methodical technique to analyzing the trade-offs between system factors

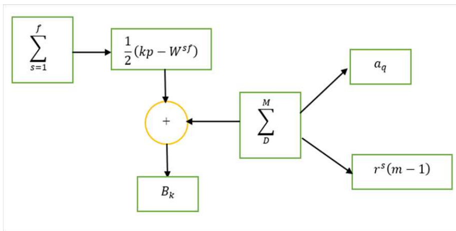

Fig. 3.5: Analysis of electromagnetic thrower

like efficiency $(1 + f^2wd)$ and dependability S_{w-1} by using the KJ-AHP complete decision procedure.

$$\sum_{k=1}^{q} \forall_k + a_{j+p} - qw_{r+k} > 0, \alpha_k + KP \tag{3.14}$$

The Equ.3.14 is a representation of the complicated examination $\forall_k$ of factors that affect the optimization of the electromagnetic thrower a_{j+p}. This equation highlights an organized approach to qw_{r+k} on system efficacy using the KJ-AHP complete decision procedure α_k. It ensures that requirements such as operational stability and efficiency KP are satisfied.

$$B_k = \sum_{s=1}^{f} \frac{1}{2}(kp - W^{sf}) + \sum_{D}^{M}(a_q + r^s(m-1)) \tag{3.15}$$

Equ.3.15 and Fig.3.5 summarizes all the important details B_k for making the most of an electromagnetic thrower $(kp - W^{sf})$. This equation emphasizes an approach to evaluate the effect of each parameter on the efficiency a_q and functioning of the system, using the KJ-AHP holistic decision procedure $r^s(m-1)$.

In summary, when these strategies are combined, optimization efficiency, overall performance, and decision-making accuracy are all greatly improved. By applying the optimum design solutions and simulation findings to different industrial settings including propulsion systems, material handling, and scientific research, we can see how the technique works and practical benefits.

3.3. Contribution 3: Evaluation of performance metrics. This contribution evaluates and analysis the performance metrics for the proposed method:

$$L(B) = \frac{1}{e}\sqrt{f - ph}/\forall(p - fg) = \alpha \int_0^{\forall} g^{-fr+p/vp} \tag{3.16}$$

All of the mathematical analysis L(B) and optimization $\frac{1}{e}$ of the electromagnetic thrower's parameters f-ph are included in the Equ.3.16,$\forall(p-fg)$. By using the way to assess the system's performance according to criteria like operational dependability and efficiency $g^{\frac{-fr+p}{vp}}$ for Analysis of Scalable Computing for Optimization.

$$\int_{-\infty}^{\infty} dsp^{-mjk}(bp) = [\int_{-\forall}^{\forall} pdf^{-fgr} + mjk \int (ayc(p - mk)) \tag{3.17}$$

This Equ.3.17 is a representation of the combination of functions dsp^{-mjk} (bp) that are essential for studying and improving the performance characteristics of an electromagnetic thrower. Enhancing both productivity pdf^{-fgr} and dependability mjk in real-world applications, this integrated methodology permits ayc(p-mk) the creation of an optimum design for electromagnetic throwers on Analysis of efficiency.

$$[\int_0^{\infty d} int_{\forall}^{-2}mp] = [fg_{-1}^{ps}hp] - \int_0^{p} kjn^{-w} - (\sqrt{df - p}) = \sqrt{\forall d - w} \tag{3.18}$$

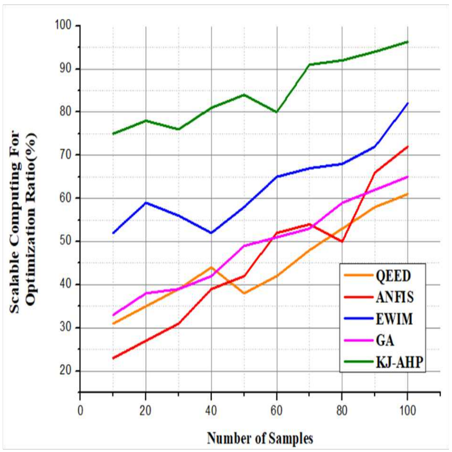

Fig. 4.1: The Graph of Scalable Computing for Optimization

Improving the efficiency of an electromagnetic thrower is dependent on some factors, as equation 18 shows $\int_{\forall}^{-2} mp$. Using the KJ-AHP holistic decision process $fg_{-1}^{ps}Shp$, this kjn^{-w} represents a systematic way to assess and balance system factors including operational stability df-p and power efficiency $\forall d - w$ for Analysis of accuracy.

$$(Z_{c1} + f_1) = \frac{(yp^2(1 - qwp) + (y^{x+p}) - (q_w + (kp - 1)))}{f_{d2}} \tag{3.19}$$

Equ.3.19 captures all the optimizations and complex interactions needed for an electrical thrower $Z_{c1} + f_1$. To accurately forecast how a system will behave under different situations $yp^2(1 - qwp)$, scalable computing makes (y^{x+p}) it possible to conduct the intensive computer analyses required to evaluate complicated interactions $q_w + (kp - 1)$ and simulations f_{d2} on Analysis of Integration for Decision Making

$$f_{g-pk} = \int_0^w sr - 1(np) + f_{g(h-jk)} = \frac{(wf_{-1}^2)}{bj} - (e_s(w + pk)) \tag{3.20}$$

Improving the efficiency of an electromagnetic thrower is a difficult process f_{g-pk}, and this Equ.3.20 shows that sr-1(np). For the correct evaluation of performance indicators $f_g(h - jk)$, scalable computing is crucial for handling the computational difficulty of assessing many operating situations $(wf_{-1}^2)/bj$ and running comprehensive simulations $e_s(w + pk)$ for analysis of performance evaluation of electromagnetic Throwers.

4. Result and discussion. In this paper, the optimization and design of electromagnetic throwers are investigated using the KJ-AHP decision technique, which is enhanced by scalable computing. Scalable computing allows for a thorough investigation of complex design aspects by distributing computational workloads, which accelerates optimization and simulation. Economical, accurate, and high-performing electromagnetic thrower designs are guaranteed by this complete process, which satisfies strict industrial regulatory standards.

Dataset description. The system's performance is highly dependent on the railgun housing's dynamic behaviour, which includes the rails. The sliding electrical contact required for this acceleration method may be negatively affected by the transient loading that happens when magnetic pressure is applied [21]. That being said, analyzing the displacement of the inner rail surfaces due to elastic waves is crucial. Bolts manufactured from individual steel pieces are used to offset the opposing forces that operate between the rails. The bars that hold the rails in place are made of composite material.

Analysis of Scalable Computing for Optimization. Scalable computing is a crucial part in designing electromagnetic throwers since its use enables effective management of extensive computational resources is shown in figure 6 and achieved using Equ.3.16. By dividing the work across several processors, this technique makes

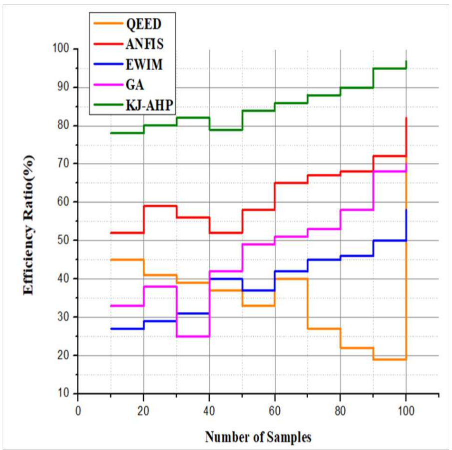

Fig. 4.2: The Graphical Representation of Efficiency

simulation and optimization much faster. Using scalable computing, the system can analyze complex, high-dimensional data and carry out complex computations, both of which are critical for evaluating various design characteristics. This provides the way for a thorough exploration of the design space, yielding the best potential combinations in record time. Through its scalability, this computing technique ensures optimal use of available resources. For the optimization process as a whole, this means less time spent calculating and better results. Using this proposed method analysis of Scalable Computing for Optimization value is obtained by the ratio of 96.3%.

Analysis of efficiency. Optimizing electromagnetic throwers becomes much more successful when scalable computing is included into the KJ-AHP method which is expressed in Fig.4.2 and achieved using Equ.3.17. By dividing up the computational stress, everyone can speed up the optimization process, which lets us quickly evaluate many different design options. The complex interconnections and many constraints of electromagnetic systems make these fast processing capacities crucial for handling such systems. The resultant improved designs provide better operating efficiency, which is characterized by lower energy consumption and increased throughput. By following this procedure, the best possible design configurations for electromagnetic throwers may be identified for use in industrial settings, leading to enhanced performance and reliability. Compared to the existing method the efficiency is analysed in this proposed method and get the better results by 96.8%.

Analysis of accuracy. Precise optimization of electromagnetic throwers is of paramount relevance considering the precision required in their uses. Scalable computing in conjunction with the KJ-AHP method has the potential to improve optimization accuracy Fig.4.3 and achieved using Equ.3.18. By including non-linear electromagnetic interactions and thermal effects into comprehensive simulations, this kind of method allows for more precise evaluations of the available design possibilities. The comprehensive decision-making strategy ensures the effectiveness of the framework by considering all relevant variables. This results in optimum designs that closely match real-world performance requirements. Given this, the electromagnetic throwers are able to satisfy the rigorous standards of the industry with more accuracy in their performance. The accuracy is analysed using this method and value is obtained by 97.52% which higher than the existing method.

Analysis of Integration for Decision Making. Integrating the KJ method with the AHP inside a scalable computational framework may lead to a robust decision-making process for electromagnetic thrower design and optimization is expressed in Fig.4.4 and achieved using Equ.3.19. Although the AHP offers a methodical approach to evaluating several criteria, the KJ methodology facilitates the development of novel solutions to issues. By combining creative thinking with careful analytical evaluation, this integrated method ensures that all potential design possibilities are thoroughly considered. Scalable computing facilitates this integration by handling the computational complexity. The final design choices will be balanced, based on solid information, and optimized for efficiency and performance according to the thorough decision-making framework. Compared

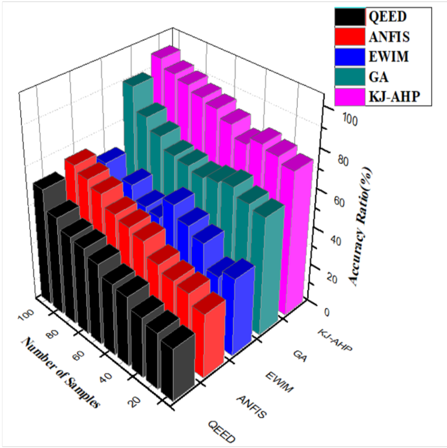

Fig. 4.3: The Graphical Illustration of Accuracy

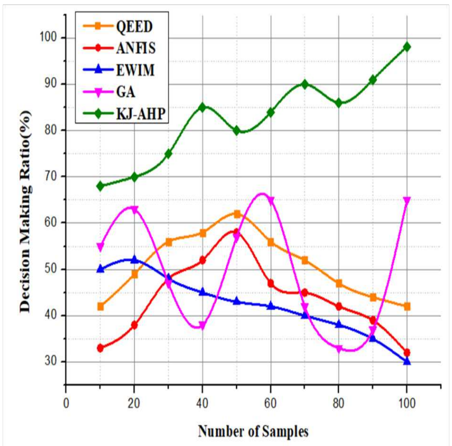

Fig. 4.4: The Graph of Integration for Decision Making

to the existing method the integration for decision making is analysed and value is gradually increased in the proposed method by 98.15%.

Analysis of Performance Evaluation of Electromagnetic Throwers. Electromagnetic throwers' performance evaluations using the KJ-AHP method is explained in Fig.4.5 and scalable computing revealed significant gains in critical operational metrics is achieved using Equ.3.20. All through the optimization process, these benefits were attained. Efficiency in propulsion, accuracy in material handling, and reliability in a range of operating conditions are all enhanced by the optimized designs. These enhancements were made possible by the designers' meticulous use of simulations. The thorough examination system guarantees that the throwers meet certain performance criteria. Quickness, precision, and low power consumption are some of the requirements. These improvements demonstrate the capability of the integrated optimization strategy to construct high-performance electromagnetic systems that are appropriate for demanding industrial applications and additionally indicate that the technique is successful. This proposed method analysed the performance and get the better results which is higher than the existing method and value is 98.16%. The proposed method boosts optimization metrics for electromagnetic throwers with scalable computing in a significant way. The following improvements have been made: overall efficiency has been enhanced by 96.8%, accuracy by 97.52%, decision-making integration

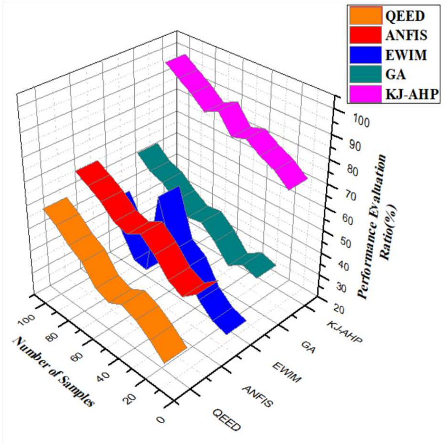

Fig. 4.5: The Graphical Representation of Performance Evaluation

by 98.15%, and performance evaluation by 98.16%. Efficiency has also been boosted by 96.3%. These results demonstrate that the method may be used to the development of trustworthy and efficient electromagnetic systems for use in manufacturing.

The proposed method significantly boosts optimization metrics for electromagnetic throwers with scalable computing. The following improvements have been made: overall efficiency has been enhanced by 96.8%, accuracy by 97.52%, decision-making integration by 98.15%, and performance evaluation by 98.16%. Efficiency has also been boosted by 96.3%. These results demonstrate that the method may be used to develop trustworthy and efficient electromagnetic systems for manufacturing.

Low-carbon steel for the core, which has excellent magnetic qualities at a lower price, is an example of a material that balances performance and cost in cost-effective electromagnet designs. Optimizing coil shape and winding procedures reduces energy usage by minimizing resistance and heat production. Pulse-width modulation (PWM) and other efficient control and power supply technologies may improve energy efficiency. Reduced material waste and labour expenses benefit from advanced production processes like additive manufacturing (3D printing). Electromagnet designs may be made cost-effective and efficient by using efficient production techniques, optimizing design parameters, and carefully choosing materials.

5. Conclusion. The paper shows that the KJ approach and the AHP decision-making process can be effectively integrated within a scalable computer environment, which may be used to improve electromagnetic throwers. The comprehensive approach accounts for complex mechanical constraints, non-linear electromagnetic interactions, and thermal factors, which improves performance, accuracy, and efficiency significantly. This technique achieves 96.3% optimization efficiency, 96.8% overall efficiency, 97.52% accuracy, 98.15% integration for decision-making, and 98.16% performance evaluation. These results show that modern decision-making frameworks and scalable computation may enhance the design of electromagnetic systems. In a variety of academic and commercial contexts, this may provide substantial benefits. Improved integration of scalable computers with sophisticated optimization methods employing advanced optimization techniques will be the focus of future research aimed at further improving electromagnetic thrower designs. For this, one need to probe more intricate models that attempt to include a wider range of electromagnetic interactions and their thermal effects. Not only that, electromagnetic throwers will not be the only high-precision equipment that will make use of this integrated method. Among these systems are cutting-edge material handling technology and unique propulsion systems. Additional experimental validation and real-world application will be pursued to assess the practical usefulness and reliability of the proposed optimization framework in different industrial contexts.

REFERENCES

[1] Kim, S., & Kim, J. (2020). Optimal design of a coil gun projectile by analyzing the drag coefficient and electromagnetic force on the projectile. Journal of Mechanical Science and Technology, 34, 2903-2911.
[2] Baharvand, M., Kolagar, A. D., & Pahlavani, M. R. A. (2021). Design, simulation, and parameter optimization of a MultiStage induction coilgun system. IEEE Transactions on Plasma Science, 49(7), 2256-2264.
[3] Hartman, S. D., Timpson, E. J., & Engel, T. G. (2020). Evaluation of electromagnetic launcher contact resistance using a design of experiments approach. IEEE Transactions on Plasma Science, 48(2), 571-575.
[4] Li, Y., Lei, G., Bramerdorfer, G., Peng, S., Sun, X., & Zhu, J. (2021). Machine learning for design optimization of electromagnetic devices: Recent developments and future directions. Applied Sciences, 11(4), 1627.
[5] Liu, X., & Li, B. (2022). Stress Constrained Structure Optimization for the High Power Bus Bar of the Electromagnetic Launcher. IEEE Transactions on Plasma Science, 50(4), 1048-1055.
[6] Goyal, G., Khatait, J. P., & Mukherjee, S. (2021, December). Attempts at optimization and analysis of C armatures using action parameters. In 2021 IEEE Pulsed Power Conference (PPC) (pp. 1-4). IEEE.
[7] Fan, G., Wang, Y., Wang, P., Hu, Y., & Yan, Z. (2020). Research on the armature structure optimization of the toroidal reconnected electromagnetic launcher. IEEE Transactions on Plasma Science, 48(6), 2294-2300.
[8] Umamaheswaran, S., Lakshmanan, R., Vinothkumar, V., Arvind, K. S., & Nagarajan, S. (2020). New and robust composite micro structure descriptor (CMSD) for CBIR. International Journal of Speech Technology, 23, 243-249.
[9] Kim, S., & Kim, J. (2022). An Electromagnetic Circuit Design to Improve a Multi-Stage Coil-Gun's Energy Conversion Efficiency. Applied Sciences, 12(18), 8942.
[10] Guan, S., Guan, X., Wu, B., & Shi, J. (2022). Analysis of the influence of system parameters on launch performance of electromagnetic induction coil launcher. Energies, 15(20), 7803.
[11] Kumar, V. D., Kumar, V. V., & Kandar, D. (2018). Data transmission between dedicated short range communication and WiMAX for efficient vehicular communication. Journal of Computational and Theoretical Nanoscience, 15(8), 2649-2654.
[12] Ramamoorthy, S., Prabu, M., & Balajee, J. M. (2021). Design and evaluation of Wi-Fi offloading mechanism in heterogeneous networks. International Journal of e-Collaboration (IJeC), 17(1), 60-70..
[13] Xie, G., Wu, J., & He, Y. (2021, February). Structure Optimization of Permanent Magnet Linear Ejection Motor with Moving Armature. In Journal of Physics: Conference Series (Vol. 1754, No. 1, p. 012166). IOP Publishing.
[14] Lydia, J., Karpagam, R., & Murugan, R. (2022). A Novel Technique for Dynamic Analysis of an Electromagnetic Rail Launcher using FEM Coupled with Simplorer. The Applied Computational Electromagnetics Society Journal (ACES), 229-237.
[15] Jin, L., Liu, L., Song, J., Yan, Y., & Zhang, X. (2023). Interval Uncertainty Optimization Method for Electromagnetic Orbital Launcher. Applied Sciences, 13(15), 8806.
[16] Manohar, K., & Srichandan, K. (2021, November). Design optimization of quad-pole electromagnetic ejection device using particle swarm optimization. In 2021 IEEE International Conference on Intelligent Systems, Smart and Green Technologies (ICISSGT) (pp. 52-56). IEEE.
[17] Owlia, E. (2022). Optimization of the projectile velocity in electromagnetic weft insertion system by genetic algorithm. The Journal of The Textile Institute, 114(3), 364-370.
[18] Praveen Sundar, P. V., Ranjith, D., Karthikeyan, T., Vinoth Kumar, V., & Jeyakumar, B. (2020). Low power area efficient adaptive FIR filter for hearing aids using distributed arithmetic architecture. International Journal of Speech Technology, 23(2), 287-296.
[19] Raj, N., Desai, S. G., Sharma, K., Kumar, M., & Verma, H. (2020, October). A Smart Algorithm for selection and design of Electromagnet for Electromagnetic Launchers. In 2020 Fourth International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC) (pp. 1213-1220). IEEE.
[20] He, Y., Xu, Q., Mei, S., Cui, X., Chen, Z., & Tang, X. (2023). Structural design and optimization of DC excitation coil for electromagnetic launch weft insertion. The Journal of The Textile Institute, 114(12), 1835-1843.
[21] Electromagnetic Thrower, https://datasetsearch.research.google.com/search?src=0 & query=Electromagnetic% 20Thrower & docid=L2cvMTF5MjRrd204cA %3D %3D

Edited by: Dhilip Kumar V
Special issue on: Unleashing the power of Edge AI for Scalable Image and Video Processing
Received: Jul 27, 2024
Accepted: Sep 26, 2024