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CONTENT

AI APPLICATIONS IN X RAY DIFFRACTION CHARACTERIZATION

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ABSTRACT

This paper presents the results and variations obtained using artificial intelligence in the process of phase characterization by X-ray diffraction, as well as the results of the characterization of the synthesized material. The novelty is the approximation possible using AI, were compared the results using three different Artificial Intelligences. The synthesis was carried out via mechanochemical methods using the precursor materials Fe_2O_3 and Cr_2O_3, followed by 7 hours of milling. For traditional characterization, a Bruker diffractometer was used, along with EVA software and the ICDD PDF2+ database. The AI information was compared with traditional method find variations, but in the generation of profile was satisfactory.

Keywords: AI in characterization of materials, X Ray Diffraction, iron chromium oxide, chromite, generation PDF data with AI

CONCLUSION (SUMMARY)

The study showed that Gamma's artificial intelligence detected two phases that closely matched the obtained result, allowing the user to determine that the synthesis occurred in an iron-chromium-oxygen system $(FeCr)_2O_3$. With Claude app, it was only possible to approximate the iron-chromium-oxygen phase; in both cases, Fe_2O_3 was identified, which is a step forward. One of Claude's advantages is the generation of diffraction profiles containing information on the phase's chemical composition, which represents a significant advancement in characterization by making that information available. Over time, analysis will likely become easier due to improved functions and greater availability of data. The information regarding nanoscale size and micro deformation provided by Gamma was accurate. Today there are variations due to limitations of profiles of XRD in the web, but the generation of profiles with Claud app is a good way to explore with AI.

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SOFTWARE STANDARDS AND METRICS IN MODERN SYSTEMS DEVELOPMENT: A QUANTITATIVE APPROACH TO QUALITY IMPROVEMENT

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ABSTRACT

Software quality is a critical factor in the development of modern systems, particularly in areas such as mobile applications, web development, artificial intelligence, and the Internet of Things. This study analyzes the implementation of international standards and software metrics as tools for improving product quality and the efficiency of the development process in several academic study cases. A quantitative model based on standards such as ISO/IEC 25010 and ISO/IEC/IEEE 15939, integrated into agile methodologies, is proposed. Using a correlational design, the impact of process and product metrics on software projects was evaluated. The results show a significant reduction in defects and an improvement in productivity, supporting the importance of their systematic adoption.

Key words: software metrics, software quality, standards, ISO 25010, DevOps.

CONCLUSION (SUMMARY)

The study found that metrics significantly improve quality; standards provide structure and control, so integrating them into agile methodologies enhances results. Through this integration, it is possible to apply standards and metrics in a viable and repeatable manner as was observed in the different study cases apply in various services.

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RECONSTRUCTION OF ENGINE BLOCKS THROUGH ON-SITE GRINDING OF HIGH-DEMAND ENGINE MONOBLOCKS IN MEXICO: 1.6, 2.5, AND 1.8.

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ABSTRACT

This paper presents the recovery of high-demand engines from vehicles in Mexico, showing the step-by-step process and equipment required to achieve high-performance functionality of the engines. The aim is to share the favorable results obtained, indicating the sequence of activities, and for this work to be of great help as a reference to contribute to reducing environmental impact, applying trends in giving new uses to products, contributing to the recycling of parts using low-cost equipment, and seeking to be accessible to SMEs. This project was developed in a practical manner by professional staff from the company Refacciones Servicio y Mantenimiento Automotriz STAR S de RL de CV. It is from this point of view that the authors, together with the organization, decided to develop this project for machine tool operators, which describes in detail, step by step, the process of one of the most common engine grinding jobs they perform, namely bed grinding (in-line cutting), implementing technical and empirical data as well as graphic examples of engines that have required this service. The purpose of this work was to provide a support guide for all those who are starting out in this area of the automotive sector. It is also hoped that it will serve as feedback for those who already have experience in this work and serve as a reference for them.

Key words: monoblock, grinding, rectificado, crankshaft, bancada, reconstruction

CONCLUSION (SUMMARY)

In summary, engine block machining remains relatively unknown compared to other areas in the automotive mechanics sector. To broaden its reach, this project was developed to help those new to the field better understand the process of machining a monoblock engine block. It also aims to highlight the importance of this type of work for Mexico and Latin America.

This process manual provides a step-by-step guide to crankshaft honing, using the monoblocks from the three most popular vehicles in Mexico as test subjects, and applying the scientific method through experimental research.

The process began with the receipt of the engine block, followed by an assessment of its condition upon arrival. It then proceeded to the subsequent stages of the process (welding and machining), with a detailed description of the correct methods for performing these tasks for the reader. Finally, the results of the aforementioned process were compiled to determine its viability as a form of corrective maintenance for vehicles with severe damage to the engine block.

That is why the execution and dissemination of this type of work helps raise awareness of automotive engine reconditioning, fostering a better-prepared community with access to more information.

In conclusion, it is hoped that this work will serve as a resource for training new staff at companies and workshops, enabling them to provide a higher-quality service.

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FIRST PASSAGES: PARENTS, CHILDREN, AND THE TRANSITION INTO EARLY CHILDHOOD EDUCATION IN MALTA

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ABSTRACT

This study explores how parents in Malta experience and support their children's transition into early childhood education. Using interviews with 15 parents and questionnaires from 51 parents, the study draws on Van Gennep's Rites of Passage, supported by Bronfenbrenner and Vygotsky.

Findings show that parents prepared children through school visits, positive conversations, role-play, visual calendars, storybooks, and routines. However, many still felt anxious: 47% reported anxiety and 35% felt both excited and concerned. Children's reactions varied, with 58% nervous at first but quick to adjust, while 29% remained upset for longer.

The adjustment phase was the most challenging. Parents reported mood changes, sleep problems, clinginess, regression, and stress-related physical complaints. Most children settled within one to two months, and 82% later showed improved mood and confidence. The study highlights that parents also undergo a transition as they build trust in the educational setting.

CONCLUSION (SUMMARY)

The study concludes that transition into early childhood education should be understood as a shared family process rather than a child-only event. Children's adjustment was supported by emotional preparation, predictable routines, educator sensitivity, and regular communication between home and school. Parents felt more secure when educators offered reassurance, feedback, and flexible support during the early weeks of schooling.

These findings have practical implications for early years settings and policymakers. Gradual induction programmes, structured parent orientation, consistent communication protocols, and culturally responsive support can reduce anxiety and strengthen children's sense of security. Although the study is geographically focused on Malta and based on a modest sample, it contributes to transition research by foregrounding parental voices and showing how successful transitions depend on relationships, trust, and sustained support around the child.

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MAKING MUSIC, MAKING MEANING: EDUCATOR INSIGHTS ON AUTISM AND MUSICAL ENGAGEMENT

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ABSTRACT: This qualitative study explores how primary music educators in Malta understand and support the inclusion of students with autism in mainstream music classrooms. Based on semi-structured interviews with fifteen educators working across state, church, and private schools, the study examines teacher preparedness, classroom strategies, observed student outcomes, collaboration with support staff, and institutional challenges. The analysis is informed by the neurodiversity paradigm, Universal Design for Learning, and sociocultural theory. Findings show that most educators value inclusion, but many have received little autism-specific or music-specific training. As a result, teachers often rely on practical strategies developed through experience, including predictable lesson routines, visual supports, movement-based work, adapted instruments, repetition, and flexible forms of participation. Educators reported that music could support emotional expression, attention, confidence, and social engagement for students with autism, especially when activities were structured yet responsive to individual needs. However, these positive outcomes were often achieved despite systemic limitations, including limited planning time, uneven collaboration with Learning Support Educators, insufficient resources, and inconsistent institutional support. The study contributes to an under-researched area by foregrounding the voices of music educators within Malta's small-state inclusion system. It argues that inclusive music education requires more than goodwill: it needs targeted training, accessible resources, and school structures that recognise music as a meaningful part of inclusive practice.

Key words: inclusive music education, autism spectrum disorder, teacher perspectives, neurodiversity, Universal Design for Learning

CONCLUSION (SUMMARY) The study shows that music can offer students with autism a powerful space for communication, participation, and shared meaning-making. Teachers in Malta demonstrated creativity and commitment, but their practice was often shaped by gaps in training, resources, and institutional coordination. A stronger approach to inclusion should embed autism-specific preparation in teacher education, provide adapted musical materials, and create regular planning time between music educators, Learning Support Educators, and class teachers. Although the study is grounded in the Maltese context, its findings speak to wider debates about how specialist subjects can support neurodivergent learners. Music should be treated not as an extra activity, but as a legitimate and valuable part of inclusive education.

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[2] Simon Farrugia is an author and lecturer at the Malta Leadership Institute where he teaches courses related to the field of education. His research interests lie in ethnomusicology, particularly Maltese musical traditions, audiovisual research, and the semiotics of music, and in education, with an emphasis on inclusion, creativity, and the sociology of schooling. His academic work includes a television documentary series on world music and a co-authored book on Maltese historical anthropology, in addition to several publications in music education and ethnomusicology. His most recent publication is the monograph The Maltese Wind Band: A Musical Tradition and Its Practice Today (McFarland, 2023) as well as the ethnographic film Sounds of Weeping: Funeral Marches in Maltese Society and Culture which premiered at the 48th International Council for Traditions of Music and Dance world conference in January 2025 in Wellington, New Zealand. He also serves on the Malta National Committee of RILM (Répertoire International de Littérature Musicale).

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PEDAGOGICAL BOUNDARIES AND COMPETENCE PRESERVATION IN AI-ASSISTED LEARNING ENVIRONMENTS

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ABSTRACT

The integration of artificial intelligence into education has become one of the most significant pedagogical transformations of recent years. AI-based systems can provide personalized support, rapid feedback, and reduce certain routine cognitive burdens. However, current discourse primarily emphasizes efficiency and accessibility benefits, while significantly less attention is devoted to the long-term effects of excessive cognitive delegation on competence development.

This paper proposes a pedagogical framework for designing competence-preserving AI-assisted learning environments. Drawing on the literature of cognitive offloading, productive struggle, desirable difficulties, and metacognition, the study examines which cognitive processes may involve pedagogical risks when excessively delegated. Particular attention is given to problem decomposition, abstraction, independent debugging, reflective verification, sustained attention, and productive cognitive effort.

The paper argues that the central challenge of educational AI integration is not the rejection or restriction of technology, but the conscious definition of pedagogical delegation boundaries. In particular, the study distinguishes between AI functioning as scaffolding, which supports learner participation and cognitive development, and AI functioning as replacement, which may bypass cognitively formative learning processes. Consequently, educational systems should be designed not only for performance optimization, but also for the long-term sustainability of human competencies.

Key words: Artificial Intelligence in Education; Cognitive Offloading; Competence Preservation; Metacognition; Productive Struggle

CONCLUSION (SUMMARY)

This paper argues that the pedagogical value of artificial intelligence in education should not be evaluated solely by efficiency, speed, or immediate task performance. While AI systems can provide meaningful support, their educational use becomes problematic when cognitively formative processes are replaced rather than scaffolded. The distinction between AI as scaffolding and AI as replacement is therefore central to competence-preserving AI integration.

The proposed perspective emphasizes that learners should remain actively involved in reasoning, verification, problem-solving, and metacognitive reflection. Educational AI should reduce unnecessary overload without eliminating productive cognitive effort. Consequently, the design of AI-assisted learning environments should preserve opportunities for autonomous reasoning, reflective judgment, and long-term competence development.

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ASSESSMENT OF PASSENGER RIDE COMFORT IN A DMU WITH A MODIFIED SUSPENSION SYSTEM

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ABSTRACT

The goal of the presented research is to assess passenger ride comfort in an urban railway vehicle. The point is, that an original suspension system equipped by steel coil spring is replaced by air spring suspension system. The research is performed by means of simulation computations. It is suggested to replace this suspension system in a DMU railway vehicle during its modernization process. The passenger ride comfort is assessed by means of the ride comfort index NMV. Fifteen points on a vehicle floor were chosen, and two running speeds of 60 km/h and 80 km/h were chosen. Simulation computations were performed on a railway track section. It was found out, that the chosen air suspension system contributes to higher level of passenger ride comfort.

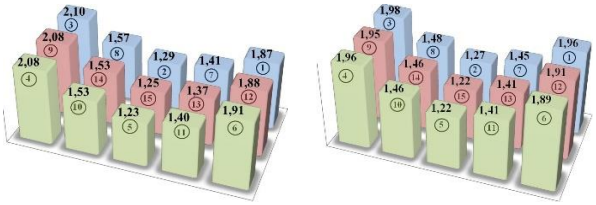
Key words: railway vehicle, ride comfort, simulation computations, suspension system

A SIMULATION MODEL

The original railway vehicle and the modernized railway vehicle are shown in Fig. 1, at which, the original vehicle is equipped with a steel coil spring. It is supposed, that the future modernization of the vehicle could include an air spring suspension.

a) b)

Fig. 1. The DMU railway vehicle: a) an original mode, b) the latest modernization of the vehicle



a) b)

Fig. 2. The achieved results of simulation computations for 80 km/h: a) coil springs, b) air spring

CONCLUSION

Railway vehicles should be able to provide sufficient level of passenger ride comfort as well as sufficient running safety during many-years operation. This, the main task is to design suitable technical solutions of modern railway vehicles. Its main task was to assess passenger ride comfort in a DMU railway vehicle. Original coil springs were replaced by air springs. This suitability of this idea was assessed based on the level of ride comfort. The examined DMU railway vehicle was considered in simulation computations. The results of the solved study prove a possible positive and potential of improvement of running properties by replacement of original steel coil springs by air spring suspension system.

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STRENGTH ANALYSIS OF AN OPEN WAGON BODY WITH STIFFENERS IN THE FRAME

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ABSTRACT

The article highlights the features of determining the strength of an open wagon body with braces in the frame during shunting collision. The presence of braces ensures a reduction in the load on the backbone beam when absorbing longitudinal loads. They are located between the rear stops of the automatic couplers and the vertical sheet of the pivot beam. The results of the calculations have proven that such an improvement is advisable. At the same time, the stress in the backbone beam is 2.7% lower than in a typical design. The conducted research will contribute to the creation of measures aimed at improving the efficiency of the operation of railway cars.

Key words: open wagon, design improvement, structural strength, body stress state, railway transport

CONCLUSION

To reduce the maximum equivalent stresses in the node of interaction of the backbone beam with the pivot, it is proposed to install reinforcing linings on the lower shelves of the backbone beam. It is important to note that such a solution allows for stress reduction in the backbone beam of the car frame in its cantilever part, and not in the node of interaction with the pivot beam. The analysis of scientific publications proves that the issue of improving wagon bodies to improve their durability in operation requires further research. The purpose of the research is to create structural solutions to improve the strength of the open wagon body in operation:

- to propose solutions to improve the open wagon body to reduce its load in operation;
- calculate the strength of the open wagon body.

Fig. 1. A spatial model of the open wagon body

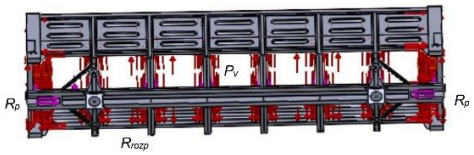

Fig. 2. A calculation diagram of the open wagon body.

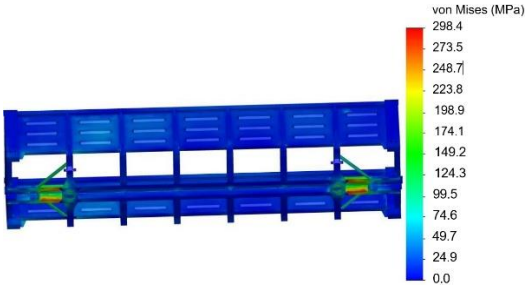

Fig. 3. The stressed state in the open wagon body.

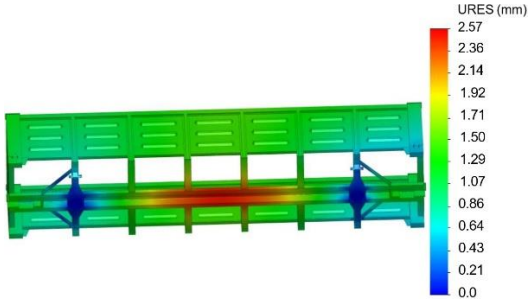

Fig. 4. Deflections of the open wagon structure.

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DEEP LEARNING WITH ATTENTION MECHANISMS FOR SMOG FORECASTING UNDER EXTREME CONDITIONS

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The article “Deep Learning with Attention Mechanisms for Smog Forecasting under Extreme Conditions” presents an advanced approach to air quality prediction using deep learning methods. The main objective of the study was to develop a model capable of accurately forecasting PM10 and PM2.5 concentrations, especially during rapidly changing atmospheric conditions and extreme smog episodes.

The proposed solution is based on a hybrid architecture that combines Long Short-Term Memory (LSTM) neural networks with an attention mechanism. The model processes multivariate time-series data containing environmental and meteorological variables such as temperature, humidity, atmospheric pressure, wind speed, and wind direction. The attention mechanism enables the model to dynamically focus on the most informative time steps, improving the extraction of temporal dependencies and increasing prediction accuracy.

The effectiveness of the proposed approach was compared with baseline models, including a standard LSTM and the NARX model. Experimental results demonstrated significant improvements in forecasting performance. For PM10, the RMSE value decreased from 17.1 to 13.5, while for PM2.5 it decreased from 20.3 to 16.2. At the same time, the coefficient of determination (R^2) improved from 0.81 to 0.88 for PM10 and from 0.78 to 0.85 for PM2.5. The proposed hybrid architecture consists of stacked LSTM layers responsible for extracting short- and long-term temporal dependencies, followed by an attention mechanism that dynamically assigns weights to the most relevant time steps. This structure enables the model to better capture sudden environmental changes and rapid increases in pollutant concentrations. In comparison with conventional recurrent models, the attention-based approach demonstrated higher stability and faster adaptation to dynamic atmospheric conditions. The model also showed superior robustness during extreme pollution events, reducing the maximum relative prediction error from over 20% to approximately 5–8%. These results confirm that integrating attention mechanisms with deep recurrent neural networks can significantly improve the reliability and effectiveness of air quality forecasting systems.

An important contribution of the study is the improved interpretability of the forecasting process. By analyzing attention weights, the model can identify the most influential time periods affecting predictions. The analysis indicated that nighttime and early morning observations had the greatest impact on smog formation, which is consistent with atmospheric stability conditions. This feature supports the development of explainable artificial intelligence (XAI) in environmental monitoring systems.

The article concludes that the proposed hybrid LSTM-Attention model provides an effective and scalable solution for real-time air quality forecasting. The model can be applied in Smart City systems, environmental monitoring platforms, and early warning systems. Future research directions include the use of Transformer-based architectures and the integration of additional data sources such as satellite imagery and traffic information.

COMPARATIVE ANALYSIS OF THE PERFORMANCE OF CLASSICAL PID CONTROLLERS WITH VARIABLE PI_D STRUCTURE CONTROLLERS

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ABSTRACT: This paper compares the performance of PID controllers with variable structure in terms of their performance in controlling a second-order static object with a transport delay, compared to the performance of classical PI control.

Based on simulation models of control systems with classical PID controllers and simulations of a system with a PI_D controller with variable structure, it can be observed that using the modified structure controllers yields waveforms with shorter control times. It can also be concluded that the system with the PI_D controller has lower overshoot and a much shorter settling time than the system with the PI controller. The system with the PI controller exhibits large decaying oscillations, while the waveform with the variable structure controller exhibits minimal and rapidly decaying oscillations.

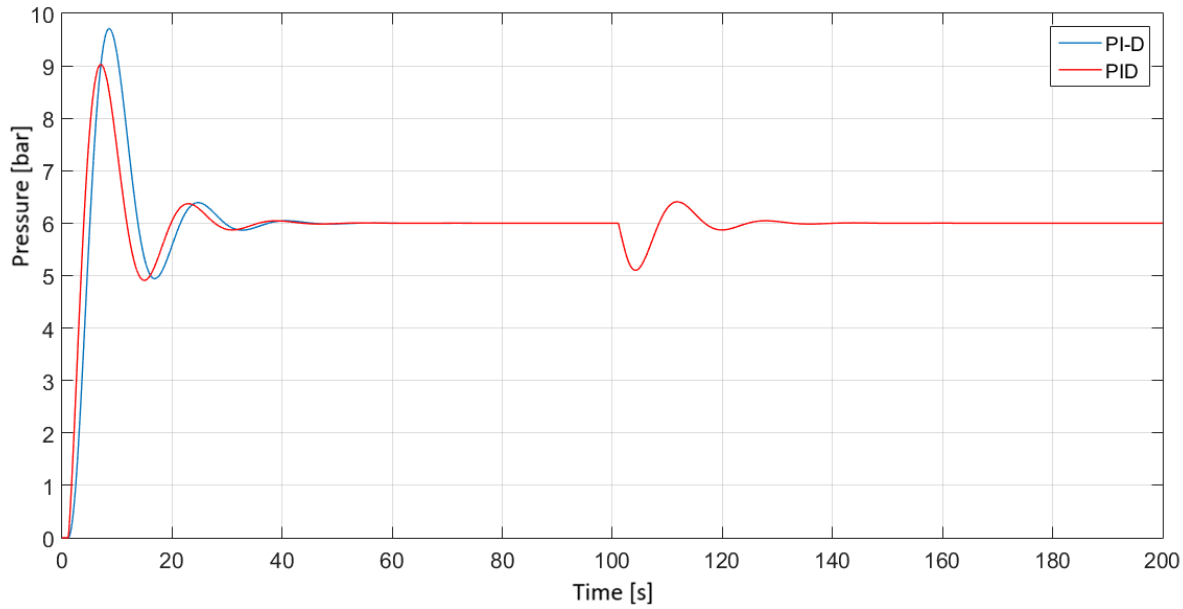

Fig. 1. Comparison of Automatic Control Systems with PI_D and PID Controllers.

Based on simulation models of control systems with a classical PID controller and simulations of the system with a PI_D variable structure controller, it can be observed that using controllers with modified structures resulted in shorter settling times. Similar conclusions can be drawn when assessing the magnitude of the overshoot. Based on Fig. 1, among other things, it can be concluded that the system with a PI_D controller has lower overshoot and a much shorter settling time than the system with a PI controller. The system with a PI controller exhibits large decaying oscillations, while the waveform with a variable structure controller exhibits minimal and rapidly decaying oscillations.

2D-3D FUSION IN MEDICAL IMAGING: METHODS, ALGORITHMS AND CHALLENGES

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ABSTRACT

This article reviews image processing methods for 2D–3D medical image fusion in surgical and interventional guidance. The main objective of the fusion is to relate current two dimensional procedural images, such as ultrasound, fluoroscopy, endoscopy, radiography, or angiography, to three dimensional data obtained from CT, MRI, 3D ultrasound, segmented structures, surface models, or anatomical reconstructions. The review focuses on the computational aspects of fusion.

The work first summarises the characteristics of the most relevant 2D and 3D medical imaging modalities. It then presents a methodological taxonomy of 2D–3D fusion approaches, including manual correspondence selection, semi-automatic methods based on landmarks and features, sensor and probe tracking, markerless surface registration, intensity based registration, projection based registration, model based fusion, deformable fusion, and machine learning methods. Particular attention is given to the strengths and limitations of each group in relation to surgical use.

The review shows that no single method is suitable for all image pairs and clinical scenarios. Projection based methods are strong in X-ray-to-CT registration, feature based and landmark based methods remain important in multimodal fusion, deformable methods are required forsoft tissue and histology related applications, and machine learning methods can improve speed and representation learning. However, all approaches remain affected by practical limitations such as initialisation, modality differences, tissue deformation, restricted field of view, computational cost, and validation difficulties.

Key words: 2D–3D fusion, medical image registration, surgical navigation, image guided surgery, multimodal imaging

STREAM-DEPENDENT BIAS IN RANDOM AFFINE LAYERS ON THE AES INVERSE

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ABSTRACT

Adaptive and key-dependent S-box schemes [4] retain the AES multiplicative inverse ı [1] in GF(2^8) but replace the fixed Rijndael affine layer with a variable (A, c) drawn from a pseudorandom byte stream G. By affine equivalence, the four classical metrics — nonlinearity 112, differential uniformity 4, boomerang uniformity 6 [3], algebraic degree 7 — are invariant across the family, so G cannot be evaluated on them. We ask whether the Hamming-weight Pearson correlation ρ_HW(S, S_AES), the quantity exploited by an AES-template CPA attacker [2], is sensitive to it.

On 10^5 instances per stream — system CSPRNG, discretised logistic map, sin(1/x) hybrid — the logistic stream gives a ρ_HW distribution 13% wider than either alternative (Levene p < 10^-180, KS p < 10^-70), while the same comparison against a uniform-random reference is null (Levene p > 0.13). The effect is therefore an interaction with the AES affine matrix, not a marginal property of (A, c).

Two controls rule out the easy explanations. A Q1.31 integer-only logistic reimplementation, free of IEEE-754, reproduces the widening at 3.1% (p = 4.3 × 10^-18): not a floating-point artefact. A discrete tent map of comparable Lyapunov exponent shows no widening (ratio 0.996): not a generic fingerprint of one-dimensional chaos.

Translated through the Mangard–Oswald–Popp trace-budget formula and validated by 216 000 Monte-Carlo attacks, the 13% widening converts into a 29% relative excess in AES-template CPA success rate at SNR = 10, N = 1000 — approximately 5 600 additional attackable devices per 10^5-device deployment. A one-byte row-rejection filter against the AES affine matrix at sampling time neutralises the dominant component at negligible cost.

Key words: *AES S-box, affine equivalence, correlation power analysis, Hamming-weight leakage, chaotic random number generation.*

CONCLUSION

The choice of pseudorandom byte stream for the affine layer of an AES-style S-box does not show up in the classical cryptographic metrics but does shift the CPA-relevant Hamming-weight correlation against the AES template. The discrete logistic map is alone among tested streams in producing this bias; integer-arithmetic and tent-map controls rule out both floating-point artefacts and generic one-dimensional chaos. For practical deployments, the system CSPRNG remains the natural default; where the logistic stream must be retained, a one-byte row-rejection filter against the AES affine matrix mitigates the residual risk.

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APPLICATION OF GROVER'S ALGORITHM TO THE 3SAT PROBLEM

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The 3-SAT problem is a core challenge in computational complexity. With the rise of quantum computing, new methods are being developed to apply quantum algorithms to NP-hard problems. This paper explores an approach using Grover's algorithm to address Boolean satisfiability. We focus on the design of a quantum oracle capable of recognizing satisfying assignments. The research also examines the limitations imposed by quantum gate implementation and the impact of quantum speedup on system scalability.
Key words: 3SAT, Grover[1], Quantum computing, speedup

CONCLUSION (SUMMARY)

The primary conclusion is that Grover's algorithm provides a quadratic speedup rather than an exponential one. While a classical brute-force search for a 3-capture assignment takes $O(2^n)$ time, Grover's algorithm reduces this to $O(2^{n/2})$. This means that while the quantum approach is significantly faster, it does not "break" the complexity of 3-SAT in the same way that Shor's algorithm breaks RSA (which provides an exponential speedup). The problem remains fundamentally difficult even for quantum computers.
A critical bottleneck is the cost of the Oracle. To use Grover's algorithm, one must implement the 3-SAT constraints as a quantum circuit (the Oracle).

- As the number of variables (n) and clauses (m) increases, the complexity of the quantum circuit required to evaluate the 3-SAT formula grows significantly.
- If the overhead of constructing and executing this complex circuit exceeds the time saved by the quadratic speedup, the quantum advantage may be negated in practical applications.

This study explores the implications of deviating from the theoretically optimal number of Grover iterations in the presence of environmental decoherence. We investigate whether a "sub-optimal" execution characterized by fewer iterations and a reduced success probability yields a lower total computational overhead when accounting for the cumulative error rates inherent in NISQ (Noisy Intermediate-Scale Quantum) devices.
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PRICE PREDICTION AND CLASSIFICATION OF RESIDENTIAL REAL ESTATE LISTINGS USING MACHINE LEARNING

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ABSTRACT

This paper presents a machine-learning approach to predictive analysis of residential real estate listings. The research problem is formulated as two supervised tasks on tabular data: regression of unit price and classification of price attractiveness relative to expected market level. The aim is to support valuation and preliminary screening of potentially underpriced listings.

The study uses 1,573 listing records from Łomża and neighbouring municipalities, cleaned and structured with the Bielik-1.5B language model and the Polars library. Predictors include area, total price, location, distance from the city centre, area segment and listing metadata. The workflow includes cleaning, outlier control, variable transformation, one-hot encoding, feature engineering and model validation in scikit-learn. Random forest was selected because it can represent nonlinear relationships and interactions typical of real estate data.

For unit-price regression, RandomForestRegressor initially reached $R^2 = 0.46$ and MAE = 51.6 PLN/m² on data with extreme observations. After filtering outliers, performance improved to $R^2 = 0.89$ and MAE of approximately 22 PLN/m². In the classification task, listings were labelled as Underpriced, Market Price or Overpriced using segment-specific medians; RandomForestClassifier achieved 71% accuracy, with F1-scores of 0.75 for underpriced and 0.76 for overpriced listings.

Key words: machine learning; regression; classification; real-estate price prediction; random forest; decision-support systems

CONCLUSION (SUMMARY)

The results confirm that combining regression and classification can support both value estimation and opportunity detection on local real estate markets. The random-forest model proved suitable for tabular listing data with nonlinear relationships between area, location and price.

The method can provide a basis for decision-support and recommender systems, but it should not replace legal, technical or investment due diligence. Future work should incorporate qualitative features such as utilities, access conditions, landform and landscape attributes, and should examine temporal changes in the regional market.

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RADIX-3 ADVANTAGES IN HIGH-FIDELITY QUANTUM EMULATION: BRIDGING THE GAP BETWEEN CLASSICAL AND QUANTUM STATES

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ABSTRACT: Classical emulation of quantum systems is an indispensable tool for verification and benchmarking, yet it is fundamentally limited by the exponential growth of Hilbert space. Conventional simulators rely on binary (radix-2) architectures, which introduce representational and arithmetic inefficiencies when emulating non-binary quantum systems such as qutrits. This work is an analyze of ternary (radix-3) classical architectures asa mathematically aligned substrate for quantum emulation. It can be shown that ternary logic provides (i) an isomorphic mapping to qutrit Hilbert spaces, (ii) improved radix economy for memory and interconnects, and (iii) reduced arithmetic/control overhead via Balanced Ternary representations of signed amplitudes. The scope of the claim is explicitly bounded: radix-3 does not remove exponential Hilbert-space scaling, but can reduce architectural friction in qutrit-native workloads. An outline of a fair comparison model, benchmarking methodology, hardware pathways beyond binary CMOS, and limitations related to noise, precision, and current fabrication maturity is presented.

Key words: ternary computing, radix-3, qutrit emulation, balanced ternary, quantum emulation

CONCLUSION

Quantum simulation is constrained not only by exponential scaling but also by architectural mismatch. Radix-3 architectures align classical addressing and arithmetic more directly with qutrit Hilbert spaces, yielding improvements in state-space efficiency, index arithmetic, and signed arithmetic symmetry. The revised argument is intentionally bounded: radix-3 should be viewed as a hardware-software co-design direction for qutrit-native emulation, not as a general solution to arbitrary quantum simulation.

The most plausible path forward is incremental. Software-defined ternary representations can first be used to quantify indexing and compiler-level benefits on existing binary hardware. FPGA and mixed-signal prototypes can then test ternary data paths, Balanced-Ternary arithmetic, and analog matrix-vector acceleration. Fully native ternary hardware would become compelling only if it can preserve the mathematical alignment with qutrit state spaces while controlling noise, calibration error, and fabrication complexity.

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COMPARISON OF RULE-BASED APPROACHES AND THE LOCAL BIELIK LANGUAGE MODEL FOR INFORMATION EXTRACTION FROM POLISH REAL ESTATE LISTING PORTALS

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ABSTRACT

This paper addresses information extraction (IE) from Polish real estate listing portals. The task converts heterogeneous listing descriptions into a structured attribute-value representation covering price, area, plot type, planning status, utilities, road access and neighbourhood features. Polish listings create specific difficulties because they contain abbreviations, colloquial phrasing, non-standard unit notation, omitted relations between attributes and values, and context-dependent meanings.

The study proposes a systems-oriented research environment for comparing rule-based extraction with a local Bielik language model executed offline. The architecture combines periodic scraping on a VPS server, data transfer to a Jupyter inference environment, schema-first JSON extraction, validation, normalization, Parquet storage and integration with a BI/reporting layer. The extraction schema separates numerical, categorical and multi-label attributes and explicitly defines normalization rules and missing-data semantics.

The article defines an annotation protocol and evaluation criteria rather than a final numerical benchmark. The proposed comparison includes a Regex baseline, a Hybrid-Regex variant and the Bielik-based LLM pipeline assessed using precision, recall, F1, attribute coverage, valid output rate, normalization success and latency. The expected practical outcome is a hybrid architecture in which rules handle regular numeric fields and the LLM processes semantically dispersed attributes.

Key words: information extraction; natural language processing; rule-based methods; large language models; Bielik; real estate listings; ETL

CONCLUSION (SUMMARY)

The paper delivers a reproducible information-system architecture for Polish-language real estate IE. Its main contribution is the definition of an end-to-end pipeline and a common attribute schema that make rule-based, hybrid and LLM approaches directly comparable under controlled deployment conditions.

The next research stage should execute the benchmark on a manually annotated reference set and report errors separately for numerical, categorical and multi-label fields. The proposed framework already indicates that secure local inference and explicit validation can support scalable IE, while hybridization is likely to improve cost, robustness and maintainability.

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DESIGN AND EVALUATION OF A REAL ESTATE MARKET MONITORING SYSTEM ARCHITECTURE USING AN ETL PIPELINE AND LARGE LANGUAGE MODELS

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ABSTRACT

This paper presents the design and empirical evaluation of an automated real estate market monitoring system. The architecture combines web scraping, local Bielik inference, schema validation, normalization, time-series aggregation and publication in Power BI. The research focus is not market forecasting itself, but the data-engineering process required to deliver stable, analysis-ready data under source variability.

The case study uses three artifacts produced by the operational pipeline: a cleaned Parquet dataset of 636 listings with 15 attributes, a daily time-series layer of 124 observations, and a Power BI reporting model. The study evaluates data quality through completeness, geographic coverage, economic coverage, duplicate rate, daily-series continuity and readiness for reporting.

The results show 100.0% completeness of required fields, 91.6% average completeness of key analytical fields, 98.9% geographic coverage, 83.0% economic coverage, 80.0% of records fully ready for direct analysis and 100.0% continuity of the 124-day time series. The duplicate rate was low, at 0.63%, but the source-wise analysis revealed substantial quality differences, especially one source with reduced price and area completeness. These findings confirm the practical value of an ETL + local LLM + data-quality supervision architecture for Polish-language real estate data.

Key words: real estate market monitoring; ETL; data quality; MLOps; LLM; Bielik; Power BI; time series; data observability

CONCLUSION (SUMMARY)

The study shows that the main value of the system lies in the separation of acquisition, semantic enrichment, validation, storage and reporting stages. Such modularity prevents changes in the LLM or source portals from directly destabilizing the analytical layer.

Further development should add persistent telemetry for per-stage latency, validation-error counters, periodic repeatability tests of Bielik outputs and automatic alerts for source drift. A hybrid architecture, with rules assigned to regular numerical attributes and the LLM to semantically difficult fields, appears to be the most rational extension.

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DETERMINANTS OF INDEXING EFFECTIVENESS IN RELATIONAL DATABASE SYSTEMS

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ABSTRACT

This paper addresses the research problem of non-uniform indexing effectiveness in relational database systems. Although indexes are commonly considered a primary mechanism for SQL query optimization, their actual impact depends on the query type, predicate selectivity, data structure and the decisions made by the optimizer of a particular RDBMS engine. The aim of the study was to empirically evaluate the determinants of indexing effectiveness and to identify the scenarios in which indexes improve, only partially improve or do not improve query execution time. An experimental and comparative methodology was applied.

The study was conducted in four systems: PostgreSQL, MySQL, MariaDB and SQLite, using a real IMDb dataset containing approximately 29.4 million records in total. Ten SQL scenarios were designed to represent heterogeneous workloads: selection, equality and range filtering, sorting, text search, joins, filtered joins, ordered joins, aggregation and a multi-stage analytical query. Each query was executed in two variants: without indexes and after creating indexes on columns relevant to the scenario. Measurements were automated by means of a Java application communicating with the databases through JDBC.

The results show that the largest and most stable benefits occur for join and filtered join queries, whereas the impact of indexes on sorting, aggregation and LIKE-based text search with a leading wildcard is limited. The practical application of the results lies in supporting index design for analytical, reporting and application systems in which the index structure must be adapted to the actual workload profile.

Key words: indexing; relational databases; SQL optimization; query performance; database workloads

CONCLUSION (SUMMARY)

Indexing was confirmed as an effective but conditional mechanism for SQL query optimization. Its practical value was highest in selective filtering and join scenarios, especially when indexes enabled early dataset narrowing and efficient matching of records.

The study did not confirm uniform benefits across all SQL workloads. Therefore, index design should be based on real workload analysis, predicate selectivity assessment and execution-plan verification. For large database systems, iterative tuning with repeated measurement and EXPLAIN/ANALYZE inspection is recommended.

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MODULAR SMART MONITORING SYSTEM

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ABSTRACT

Modern technical infrastructure requires continuous environmental monitoring to ensure operational stability, safety, and rapid incident detection. Factors such as temperature, humidity, air quality, and unauthorized access may significantly affect the reliability of critical systems and technical facilities. This paper presents a modular IoT-based environmental monitoring system designed for real-time supervision of server rooms, network cabinets, laboratories, office environments, and other technical areas.

The proposed solution is based on low-power ESP32 sensor nodes and a Raspberry Pi central monitoring unit. The system supports wireless communication technologies such as Wi-Fi and LoRa, enabling flexible deployment in various environments. Environmental data collected from distributed sensor modules are transmitted to a centralized backend application developed using Python and FastAPI. The collected measurements are stored in a PostgreSQL database and visualized through a web-based dashboard interface.

The monitoring platform supports measurement and analysis of multiple environmental parameters, including temperature, humidity, carbon dioxide concentration, air quality indicators, and door status detection. The system also provides automated alerting mechanisms using e-mail, SMS, dashboard notifications, and external communication platforms. Historical data logging and trend visualization enable long-term environmental analysis and rapid anomaly detection.

The modular architecture of the proposed system allows easy expansion with additional sensor modules and monitoring functionalities. The solution is designed as a scalable and cost-effective platform suitable for both small and large technical environments. The project demonstrates that modern IoT technologies can provide reliable real-time environmental monitoring while maintaining low hardware costs and flexible deployment possibilities.

Key words: IoT, modular architecture, environmental monitoring, ESP32, Raspberry Pi, LoRa, smart sensors

CONCLUSION

The developed system demonstrates the practical application of IoT technologies in environmental monitoring and technical infrastructure supervision. The proposed architecture combines low-cost hardware, wireless communication, centralized data collection, and automated alerting mechanisms into a scalable monitoring platform. The modular design enables future expansion with additional sensors and analytical functionalities, making the system adaptable to various industrial and technical applications.

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BEYOND COMPLIANCE: A CRITICAL DIAGNOSTIC OF SLOVAK CYBERSECURITY OPERATIONAL RESILIENCE

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ABSTRACT

While the formal harmonization of Slovak cybersecurity standards with European directives (NIS1 and NIS2) has been widely documented, a critical gap remains between legislative compliance and operational readiness. This paper moves beyond the descriptive analysis of the regulatory framework specifically Acts No. 69/2018 and 366/2024 to provide a diagnostic assessment of the practical execution challenges in the Slovak digital defense ecosystem. By examining the interplay between institutional fragmentation, human capital scarcity, and organizational compliance culture, this study identifies the structural bottlenecks that hinder effective incident response. The findings offer a critical perspective on the current national cybersecurity posture, suggesting that the path forward lies in operational cohesion rather than further regulatory expansion.

Key words: cybersecurity, NIS2 directive, cybersecurity governance, national security authority, critical infrastructure resilience, regulatory implementation

CONCLUSION (SUMMARY)

Evaluated through the lens of recent legislative overhauls—most notably the transposition of the NIS2 directive the Slovak regulatory framework has undeniably achieved a profound degree of formal harmonization with European Union mandates. The contemporary security architecture is anchored by significant structural merits, including a modernized legal code, revitalized strategic forecasting, and the presence of a robust, centralized oversight mechanism.

Nevertheless, the substantive efficacy of this extensive apparatus remains entirely contingent upon overcoming practical barriers. Specifically, transitioning from mere normative compliance to genuine defensive capability requires prioritizing the maturation of enforcement practices, seamless inter-agency synchronization, and the continuous refinement of procedural safeguards. Ultimately, long-term systemic resilience will not be dictated by further regulatory proliferation, but rather by uncompromising implementation discipline and operational cohesion.

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FROM SHADOW TO AVATAR: INTERMEDIATE ONTOLOGY, TECHNO-ANIMISM, AND POSTDIGITAL THEATRE IN THE PROJECT OF THE INTERNATIONAL CENTER OF ART OF EUROPE AND ASIA

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ABSTRACT

In the era of radical technological acceleration, the classical frameworks of cultural institutions are undergoing systematic exhaustion. The International Center of Art of Europe and Asia, initiated by Prof. Jacek Kucaba, proposes a nomadic model of an artistic platform. The theatrical trend of this project functions as a laboratory of postdramatic forms, examining the relations between the body and digital technology. Postdigital theatre deconstructs the opposition between embodied and virtual participation, constructing a postdigital co-presence. Based on intermediate ontology, the avatar is treated as a natural heir to the traditional puppet, which is reflected in the phenomenon of digital puppetry. The project also draws on media archaeology, treating ancient forms, such as the Karagöz shadow theatre, as prefigurations of today's virtual reality interfaces. This is complemented by the Asian paradigm of cosmotechnics and techno-animism, which allows algorithms and artificial intelligence to be perceived as entities with vital agency.

Key words: postdigital theatre, intermediate ontology, techno-animism, digital puppetry, media archaeology

CONCLUSION (SUMMARY)

In conclusion, the theatrical current of the project consistently functions as a radical anti-archive. It rejects the static collection of dead forms in favor of a living repertoire and an open, ephemeral creative process. By deconstructing the Western division into body-memory and body-archive, this platform becomes a living ontological laboratory. New, digital actors do not alienate human experience but create a space for intercultural translation, offering tools to examine the condition of the technologically mediated subject.

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INDEX OF AUTHORS


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