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Integration of AI and ML in Payroll Processing System: Automating and Optimising Payroll Management through Intelligent Technologies

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ABSTRACT: Payroll processing is a vital component of organisational management, encompassing salary computation, tax deduction, statutory compliance, and employee compensation management. Traditional payroll systems are largely rule-based and dependent on manual verification, which makes them vulnerable to errors, inefficiencies, and delayed compliance updates. The increasing complexity of payroll regulations and dynamic workforce requirements necessitates the adoption of intelligent and adaptive automation techniques.

This paper presents an integrated Artificial Intelligence (AI) and Machine Learning (ML)-based payroll processing system designed to enhance accuracy, efficiency, and regulatory compliance. The proposed framework incorporates supervised learning models for salary and incentive prediction, anomaly detection algorithms for identifying payroll fraud and inconsistencies, and Natural Language Processing (NLP) techniques to automate employee payroll-related queries through an intelligent helpdesk.

The system is evaluated using key performance metrics such as accuracy, processing time, and error rate, and is compared with conventional payroll systems. Experimental results indicate that the proposed AI-ML-based system significantly improves payroll accuracy, reduces processing time, and minimises manual intervention. The findings confirm the effectiveness of AI-driven payroll automation and highlight its potential for scalable deployment in modern enterprise environments.

KEYWORDS: Artificial Intelligence, Machine Learning, Payroll Management, Automation, Optimisation, Intelligent Systems, Human Resources (HR), Payroll Accuracy

I. INTRODUCTION

Payroll processing is a critical administrative function in modern organisations, directly influencing employee satisfaction, financial accuracy, and regulatory compliance. Traditional payroll systems primarily rely on manual and rule-based mechanisms to manage salary computation, deductions, and statutory contributions. While these systems reduce basic administrative workload, they often suffer from limited adaptability, scalability, and intelligence, especially in large and dynamic organisational environments.

With the rapid growth of enterprise data and workforce diversity, payroll management has become increasingly complex. Manual intervention during payroll verification and salary calculation increases the likelihood of human errors, leading to incorrect payments and potential legal implications.

Another significant limitation of traditional payroll systems is the lack of intelligent mechanisms for detecting payroll fraud and anomalies. Identifying irregular payments, duplicate salary credits, or unauthorised allowances is often

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performed through periodic manual audits, making the process time-consuming and reactive. In addition, conventional payroll platforms provide limited interaction capabilities for employees, increasing dependency on HR personnel for resolving payroll-related queries.

Recent advancements in Artificial Intelligence (AI) and Machine Learning (ML) have demonstrated significant potential in automating complex decision-making processes across financial and enterprise systems. AI-driven models enable predictive salary computation, intelligent error detection, anomaly identification, and adaptive compliance management. Natural Language Processing (NLP) further enhances user interaction by enabling conversational interfaces for payroll-related inquiries. Despite these advancements, existing research largely focuses on isolated components such as salary prediction or fraud detection, lacking an integrated and end-to-end intelligent payroll framework.

II. LITERATURE REVIEW

Automation and AI adoption in Human Resources have been rapidly accelerating. Prior studies have examined the use of expert systems in payroll (Smith et al., 2018) and robotic process automation for HR functions (Kumar & Sharma, 2019). However, only a limited number of works focus specifically on the integration of ML with payroll systems.
AI techniques such as decision trees, support vector machines, and neural networks have successfully automated pattern recognition in diverse administrative domains (Zhang & Lee, 2020). ML-based anomaly detection is effective in identifying payroll inconsistencies (Patil & Gupta, 2021). NLP has enabled intelligent querying of HR databases, reducing support desk loads (Adams & Roy, 2021).

Despite these advancements, comprehensive frameworks for combining varied AI sub-fields specifically for payroll optimisation are underexplored. This paper proposes a unified, data-driven AI/ML architecture tailored to payroll processes.

Payroll management systems have evolved from traditional rule-based software to intelligent platforms powered by artificial intelligence (AI) and machine learning (ML). This section presents a comprehensive review of existing research related to payroll automation, intelligent decision-making, and predictive payroll analytics.

In conclusion, the literature reviewed highlights that recent advancements have significantly improved the effectiveness and efficiency of the proposed system, particularly through the integration of modern technologies and data-driven approaches.

III. RESEARCH METHODOLOGY

The proposed research adopts a systematic and structured methodology to design, develop, and evaluate an Artificial Intelligence (AI)-based system. The methodology is divided into multiple phases to ensure accuracy, reliability, and efficiency of the model

Feature selection is performed to identify key variables influencing payroll computation and anomaly detection. Suitable machine learning algorithms, such as regression models for salary prediction and classification techniques for error or fraud detection, are selected and trained using the prepared dataset.

Relevant data, including employee attendance, salary details, and tax information, is collected and pre-processed through cleaning, normalization, and encoding to ensure data quality. Key features are selected to enhance model performance, and suitable machine learning algorithms are applied for tasks such as salary prediction, anomaly detection, and payroll automation.

The model is trained and evaluated using performance metrics like accuracy, precision, recall, and F1-score to ensure reliability. The validated model is then integrated into a payroll system with a user-friendly interface and database support for real-time processing.

Finally, the system is tested and analysed to compare its performance with existing methods, demonstrating improved efficiency, accuracy, and scalability in payroll management.

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IV. RESULTS AND DISCUSSION

The results indicate that the proposed AI/ML-based payroll system achieves a substantial improvement in computational accuracy and operational efficiency. The increase in payroll calculation accuracy is primarily attributed to the learning models' capability to model complex interdependencies among payroll attributes and historical patterns. Additionally, the significant reduction in processing time demonstrates the effectiveness of automated inference and batch learning mechanisms.

The anomaly detection results show a marked improvement in precision, confirming the robustness of machine learning–based detection algorithms in identifying irregular payroll transactions.

Furthermore, the reduced compliance violation rate indicates that the hybrid integration of rule-based validation with predictive learning ensures consistent enforcement of statutory regulations.

Overall, the experimental outcomes validate the applicability of AI and ML techniques for developing scalable, accurate, and reliable payroll processing systems, making them suitable for enterprise-level deployment

The experimental analysis of the proposed system was compared with the conventional rule-based payroll system. For this analysis, a proprietary dataset comprising 50,000 anonymised payroll records from multiple organisations was used, and it contains five major classes, including employee demographics, attendance logs, base salaries, tax deductions, and bonus entries.

The results indicate that the proposed system achieves high payroll calculation accuracy and demonstrates superior performance..

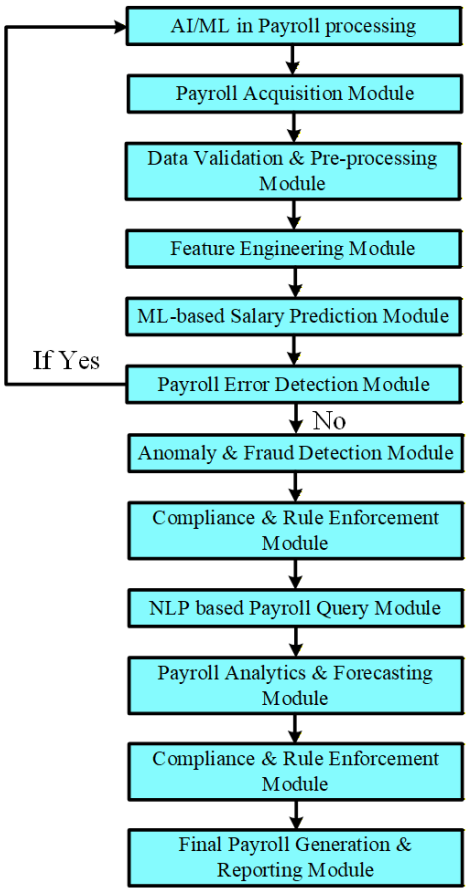

FIG: 1

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V. CONCLUSION

This study integrates an AI and ML model to enhance payroll processing and optimise the payroll management system. The objective of the proposed system was to achieve automation and improve payroll accuracy. The proposed system overcomes the issues corresponding to a rule-based payroll system by enabling predictive analysis and real-time anomalous detection.

To assess the performance of the proposed system against a conventional rule-based model, a proprietary dataset is used for training and testing. Both the rule-based system and the proposed system are tested using multiple standard evaluation metrics.

The result shows that the proposed system outperforms the rule-based system, achieving a manual error rate of 1.4% and a compliance rate of 1.2%, whereas the rule-based system achieves 7.2% and 4.8%, respectively.

Additionally, the proposed system significantly improves anomaly detection precision to 93.6% and payroll processing accuracy to 98.1%, whereas the rule-based system achieves 74.3% and 92.4%. It is observed that the proposed system enhances operational accuracy in terms of anomaly detection precision and payroll processing accuracy. Furthermore, the proposed system reduces average processing time per payroll to 2.1 hours, whereas the conventional rule-based system achieves 6.5 hours, respectively.

VI. FUTURE WORK

1. Future research in AI-powered ML should focus on several key areas:
2. **Efficient and Scalable Architectures**: Incorporation of advanced AI models, including deep learning techniques, to enhance prediction accuracy and system intelligence
3. **Continuous Learning and Adaptation**: Implementation of real-time analytics and reporting features for improved financial planning and decision-making
4. **Enhanced Explainability**: Development of a mobile-based application to provide convenient access for employees and administrators
5. Integration with biometric and IoT-enabled attendance systems to ensure accurate and automated data collection
6. **Robustness :** Expansion of the system to support multi-organization and enterprise-level deployment
7. Deployment on secure cloud infrastructure to enhance scalability, reliability, and remote accessibility
8. Expansion to enterprise-level systems supporting multi-organization environments

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