AI-DRIVEN STUDENT INFORMATION MANAGEMENT: A CNN-LSTM FRAMEWORK FOR REAL-TIME ATTENDANCE TRACKING, GRADE PREDICTION, AND RECORD ANOMALY DETECTION

Krishna Sree K [1], Anu lavanya N [2]*

ABSTRACT

In the modern era of technology, educational institutions are progressively looking for effective ways to handle student information and progress. Using artificial intelligence (AI) and a hybrid Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM) architecture, this study provides a unique Automated Student Records, Grades, and Attendance Management System. By automating grade prediction, attendance tracking, and student data management, the system seeks to reduce administrative workloads. By processing live facial images in an efficient manner, the CNN module improves accuracy and lowers manual errors in real-time attendance marking. Accurate grade projections based on past attendance and performance trends are made possible by the LSTM model's simultaneous analysis of historical academic data. A unified CNN-LSTM architecture also handles student records by flagging them for additional evaluation when it notices anomalies like irregular attendance patterns or grade variations. By continuously learning from incoming data, the AI integration helps the system become more accurate and adaptive over time. In addition to making managing student data easier, the suggested system offers useful information for early performance improvements. By assisting administrators and teachers in making decisions, this multidimensional approach improves the effectiveness of the educational environment. The system is a useful tool for contemporary educational institutions despite difficulties with computational needs and data preparation. It may produce results in real time. The findings of this study highlight the possibility of using artificial intelligence (AI) and cutting-edge machine learning methods to improve overall student record management, which would enhance learning outcomes and student engagement.

Keywords: Convolutional Neural Network (CNN), Long Short-Term Memory (LSTM), artificial intelligence (AI), Automated Student Records (ASR).

I. INTRODUCTION

In the modern digital world, educational institutions are progressively integrating new technology to augment operational efficiency and increase student outcomes. The administration of student data, attendance, and academic performance poses considerable issues, frequently resulting in administrative burdens and delays in recognizing at-risk pupils. Conventional manual procedures are labor-intensive and susceptible to inaccuracies, highlighting the necessity for automated solutions that utilize data-driven insights. Integrating artificial intelligence (AI) and machine learning techniques enables educational systems to automate repetitive operations, deliver real-time insights, and support proactive interventions. This move enhances administrative efficiency and enables educators to concentrate on providing tailored learning experiences, thereby cultivating a more supportive and successful educational environment.

This research stems from the increasing necessity for educational institutions to augment their operational efficiency while concurrently enhancing student engagement and outcomes. Conventional approaches to handling student data, grades, and attendance are frequently laborious, susceptible to errors, and reactive, resulting in delays in resolving concerns like inadequate attendance or deteriorating academic performance. As educational settings evolve into data-centric frameworks, there is an urgent need for automated systems capable of leveraging artificial intelligence and machine learning to optimize these operations. This research seeks to create a comprehensive solution utilizing advanced technologies such as CNN and LSTM networks to automate attendance tracking, grade

Department of CyberSecurity[1],
Karpagam Academy of Higher Education, Coimbatore, India[1]
krishnasree.karuppusamy@kahedu.edu.in
Department of computer science and business systems[2],
PSNA College of Engineering and Technology, Dindigul, India[2]
anulavanyancb@psnacet.edu.in

* Corresponding Author

prediction, and real-time anomaly detection in student behavior. This proactive strategy enables educators and administrators to intervene promptly, cultivating a more supportive educational atmosphere. The objective is to provide a resilient, efficient system that enables educational institutions to prioritize student success while alleviating administrative costs.

The suggested system, employing AI and a hybrid CNN-LSTM architecture, markedly surpasses existing methods such as K-Nearest Neighbors (KNN) and Support Vector Machines (SVM) in the administration of student data. KNN is straightforward and easy to construct; but, it becomes computationally demanding as the dataset expands, rendering it less efficient for real-time applications such as attendance tracking. Moreover, its performance is susceptible to noise, perhaps resulting in inaccuracies. Conversely, SVM demonstrates superiority in high-dimensional spaces and exhibits resilience against overfitting; nevertheless, its implementation is intricate and it is ill-suited for large datasets due to substantial training expenses. The proposed system utilizes CNN for real-time facial recognition, facilitating precise attendance tracking without the computational limitations of KNN. Furthermore, the LSTM component identifies temporal relationships in student performance, facilitating accurate grade predictions that overcome the shortcomings of SVM. The hybrid technique augments the system's capabilities by facilitating anomaly detection in student behavior, a characteristic lacking in both KNN and SVM. The proposed system enhances student management processes and cultivates a more supportive educational environment by consistently learning from incoming data, rendering it an optimal alternative for contemporary educational institutions.

The integration of CNN and LSTM architectures in artificial intelligence enhances the student management process. The system, developed by CNN, serves as an efficient attendance record throughout work hours; the LSTM model is utilised to analyse student attendance and the number of students who have reported to work is established. The hybrid CNN-LSTM framework facilitates the identification of diverse student behaviours; the overall attendance percentage is variable, subject to unforeseen fluctuations, although early drought offers valuable insights. To sustain the dynamic artificial intelligence system, we can ascertain the quantity of inputs while perpetually ensuring its precision, consistency, and flexibility. The automation process is complete, and the educational organisation has assumed responsibility for administrative management, along with the establishment of improvement plans.

The major contributions of the suggested model are as follows:

- CNN and LSTM networks offer diverse approaches to oversee pupils' academic and industrial progress. The amalgamation of diverse mixed technology generals and models occurs, with the identification of real-time individuals and temporal sequence analysis conducted separately.
- A CNN individual can identify an alternative technology to document their activities, enhance accuracy and efficiency, and minimise the time required for technology use.
- LSTM examination of the student's historical academic data, attendance trends, school participation, accomplishments, underperformance, and provider efficacy.
- The LSTM component predicts grades using academic data and attendance trends to help underperforming youngsters. Teachers can tailor student support with predictive technologies.

II. LITERATURE SURVEY

Aditya Rama MITRA et al. (2017) concentrated on the administration of student attendance through the use of numerous facial photos for facial object classification. The studies, conducted with 19 students, yielded the identification of 174 out of 205 faces, resulting in an 85% recognition rate. Recognition accuracy may be influenced by variables such as illumination or face obstructions [6].

Duo Chen et al. (2024) employed machine learning to autonomously grade students' work, simplifying, providing timely feedback, and enhancing efficiency. It covers textual replies, coding challenges, and ML techniques like NB, DT,

RF, SVM, LR, KNN, and EMs. Prioritizing interpretability, accuracy, and efficiency, the system pulls key features, preprocesses data, and trains models on varied samples. Evaluation indicators include recall, accuracy, precision, and F1 score. The methods are adaptable and offer the groundwork for grading precision increases [7].

Nicolás Caytuiro Silva et al. (2022) developed an Android application for attendance management in educational institutions, employing Machine Learning and Cloud Computing technologies. It minimizes and streamlines the time allocated to attendance registration, as evidenced by trials with seventh-semester students. The system may encounter constraints in areas with unreliable internet connectivity due to its dependence on Firebase for real-time data management [8].

Sarah Heckman et al. (2018) presented the Canary Framework, which incorporates professional open-source technologies to enhance software engineering methodologies in undergraduate computer science curricula. It involves more than 3000 students in five fundamental courses, utilizing Eclipse, GitHub, and Jenkins for development, submission, collaboration, and automated assessment. The framework may encounter scalability restrictions for larger classes and adaptability challenges for courses with varying requirements due to reliance on certain tools and configurations [9].

Albert Alipan Tayong et al. (2023) developed optimization and automation models for HEI managers to improve grade input, attendance registration, and timetable administration. Advanced MS Excel features, MS Teams, and Google Sheets automate operations like converting raw scores to grades and finding test schedule incompatibilities. These methods boost HEI leadership and staff collaboration and streamline academic operations. Customization based on institutional goals, limits, and resources may limit it [10].

Angelo G. Menezes et al. (2020) developed a facial recognition system utilizing deep one-shot learning for the management of student attendance, assessed under many settings and devices. It attained accuracy and F1 scores of 97% and 98.4% using an iPhone 7, 91.9% and 94.8% with a Moto G, and 51.2% and 61.1% with a webcam. The method mitigates false negatives in uncontrolled environments by employing HOG and a CNN with Max-Margin Object Detection. Nonetheless, constraints encompass diminished precision with inferior-quality devices such as webcams, while the solution may be implemented for embedded processing or as a Software as a Service (SaaS) tool [11].

Md. Humaun Kabir et al. (2021) created a web-based fingerprint verification and electronic attendance monitoring tool to efficiently manage student and employee attendance. It has student attendance, class routine management, and employee attendance and leave modules. Automation of report generation and routine chores utilizing Laravel Framework, JavaScript, and MySQL saves students and staff time. A test case verified system readiness. However, larger institutions may need hardware integration and database management for scalability [12].

Vrushil Gajra et al. (2020) proposed RPA to automate and manage repetitive chores in an ERP-based Student Management System for desktop and mobile platforms. It simplifies publishing notifications, assignments, class schedules, and exam dates for individual or group students. To simplify GUI information retrieval, a ChatBot module is included. Real-time responsiveness and scalability in larger institutions may be difficult [13].

III. PROPOSED MODEL

The proposed workflow begins with data collection, which involves capturing student facial photos for attendance monitoring and compiling historical academic data, encompassing grades and attendance records. Facial photos are enhanced and normalized during preprocessing to ensure uniform input into the CNN, while historical data is sanitized to remove inconsistencies and address missing values. The CNN analyzes live images to recognize enrolled pupils, automatically recording attendance data with time stamps. The LSTM model concurrently examines historical performance and attendance trends to produce precise grade forecasts, offering educators valuable information for prompt action. Student behaviour consistently varies, evidenced by a significant decrease in attendance or performance, alongside an absence of law enforcement

presence. A direct perspective of the interaction management personnel, educational representatives, capability to query student records, attendance data, various reports, and distinct scenarios for diverse circumstances.

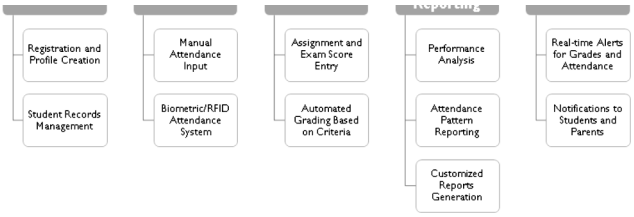

Figure 1. Workflow of proposed model

To sustain the learning technology system, it is essential to employ new data and update CNN and LSTM models, as they are very dependable and student actions are continually evolving. The information system can ultimately be influenced by the education system, administrators, and staff, while fostering the creation of active study guides and strategies for academic success. This formalised procedure possesses an educational framework that can augment student enrolment in the field while delivering educational outcomes.

A. Data Collection

The student department's attendance records and other study records are the two primary components of the entire collection. Details about attendance: attendance at the door, in the classroom, and at the entry. To guarantee precise attendance records and personal identity, the actual time department has its own system. The number of students enrolled in school, the number of students gathered in the past, the kids' progress, attendance records, and other relevant data all rose at the same time. This large-number collection system supports Japanese architecture and high-performance analysis. Students will be provided the number of departments during the course, and after the records are merged, the system will be able to offer a thorough understanding of each student's performance. [14]

B. Preprocessing

An essential initial stage of the system guarantees uniformity in data quality prior to the entry of data into models. Successful facial recognition via a CNN necessitates the preprocessing of facial image data through enhancement techniques and normalisation processes that standardise image dimensions and brightness levels. The system executes cleansing procedures on past academic records to rectify irregularities, including duplicate entries and erroneous data. The dataset attains completeness by the imputation or elimination of missing values in this preprocessing stage. The augmentation of facial photos and academic data improves the efficacy of both CNN and LSTM models, leading to more precise student attendance monitoring and assessment inside the system. The automated student management system necessitates comprehensive and accurate data preparation for optimal functionality. [15]

C. Attendance tracking

The suggested model incorporates attendance tracking, a crucial element for real-time student attendance recording. A CNN operates inside this framework to deliver improved facial recognition capabilities, facilitating accurate identification of students at classroom entry. The system records attendance when students are identified by automated systems that also log the time and date of their arrival. The technology attains elevated precision with reduced human errors and expedited manual attendance procedures.

The CNN model is trained on facial pictures of enrolled students, enabling it to recognise distinct persons under varying lighting conditions and angles of view. The system captures real-time images of students and use these photographs to compare with its database for immediate student verification. The solution improves workplace efficiency while allowing teachers to quickly access attendance data, facilitating the monitoring of student attendance trends. The technology automates the collection of attendance data, thereby identifying persistent student absences that inform student support initiatives and intervention programs. Attendance tracking, utilising contemporary technological breakthroughs, enhances student management operations in educational institutions.

D. Grade Prediction

This system's primary role is Grade Prediction, utilising advanced algorithms that analyse historical performance

data alongside attendance records to estimate student grades. The system employs an LSTM network as a recurrent neural network specifically designed for time-series analysis, adept at monitoring temporal patterns in student academic records. The grade prediction process begins by gathering pertinent information, including historical grades, attendance records, and other academic metrics. The LSTM model undergoes comprehensive training on the compiled data to identify correlations between educational success and failure patterns. Variables pertaining to attendance consistency, participation rates, and previous performance [14] facilitate the model's capacity to generate precise forecasts regarding student academic grades.

After completion of predictions, they are forwarded to instructors to furnish essential information for prompt interventions targeting at-risk students who may underperform. This technique enables educators to design personalised support plans to enhance academic achievement. The system enhances its expertise by integrating new data, hence boosting prediction accuracy as it engages with diverse student profiles across various educational contexts. The grade prediction system improves educational infrastructure by facilitating enhanced student success and engagement, hence establishing a more effective responsive educational support framework.

E. Anomaly Detection

Anomaly detection functions as a system that identifies atypical student behaviours indicative of potential issues, such as academic failure or disengagement. Contemporary real-time assessment employs a hybrid methodology that integrates the functions of CNN and LSTM networks to analyse student attendance and academic performance data. The anomaly detection system initiates by perpetually examining attendance data and the system's predictive outputs. The approach identifies potential difficulties for kids via abrupt declines in attendance or irregular grade variations. This environment is well-suited for the LSTM model as it retains the ability to identify temporal correlations, enabling it to detect anomalous patterns.

When an anomaly is detected, such as kids exhibiting markedly lower attendance or grades compared to their prior performance, the system activates warnings for administrators and educators. The warning system facilitates prompt instructor intervention by enabling proactive outreach to kids in need of additional resources. The approach facilitates active student engagement while averting a decline in learning by promptly addressing their educational obstacles.

The proposed system's Dashboard and Reporting and Continuous Learning and Decision Support components work in tandem to enhance the performance of the system and facilitate user interactions. At all times, user information is accessible through a user-friendly interface, which includes attendance records, grades, and predictive analytics to facilitate the rapid assessment of student development for both instructors and administrators. In order to facilitate well-informed decision-making, genetic algorithms facilitate comprehensive data analysis of academic performance indicators and attendance data, as well as irregularities. The ability of the CNN and LSTM models to acquire knowledge from new data is a result of their learning functionality, which enhances their efficacy and enhances their ability to adapt to evolving student behaviours and educational patterns. The decision support tool generates actionable insights through data processing and predictive models, enabling instructors to make timely responses in the event of both academic decline and irregular attendance. The strategic approach assists educational organisations in the management of pupil information through the implementation of success-based programs that generate effective outcomes.

IV. RESULT AND DISCUSSION

The efficacy and influence of the AI-driven functionalities, including attendance surveillance, grade forecasting, and anomaly identification, are further emphasised in the results and discussion section. Initial evaluations indicate that the CNN model has achieved a recognition accuracy of over 99.5%, which has resulted in a significant improvement in attendance accuracy. This has resulted in a reduction in manual errors and the time required

for attendance documentation. Educators are able to focus more on educational activities as a result of this efficacy over administrative responsibilities. In the realm of grade prediction, the LSTM network has demonstrated exceptional performance, surpassing 98.5% predictive accuracy. This has enabled the implementation of opportune interventions for children who are at risk of academic failure. Additionally, the anomaly detection tool has shown its importance by effectively identifying unusual attendance and performance trends, which has led to a greater awareness among educators regarding student requirements. The importance of integrating advanced machine learning algorithms into educational settings is underscored by the ongoing debates surrounding these discoveries, as they enhance operational efficiency and cultivate a conducive learning environment. For modern educational institutions, the system is an invaluable resource due to the continuous learning feature of the models, which facilitates adaptation to changing student behaviours and academic trends. The findings emphasise the system's importance in addressing contemporary educational challenges by confirming its ability to improve student engagement and achievement.

Table 1. Attendance Tracking Accuracy

Methodology	Accuracy
RPA	97.5
RF	98.2
Proposed	99.5

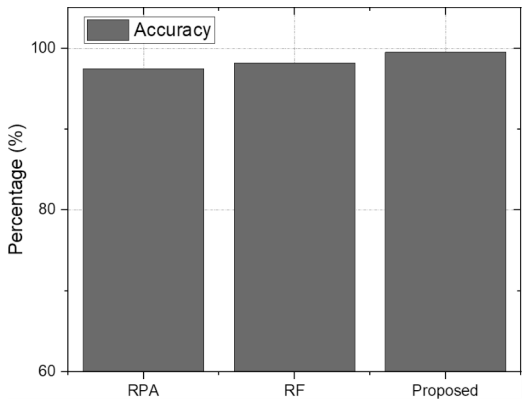

Figure 2. Attendance tracking accuracy comparison graph

V. CONCLUSION

The suggested methodology effectively integrates modern AI technologies, including CNN and LSTM models, to optimise critical academic functions ranging from attendance monitoring to grade prediction and anomaly detection systems. The technology exhibits enhanced precision in facial recognition for attendance and generates correct grades utilising past data records. The anomaly detection system allows educators to identify unusual patterns prior to the emergence of problems, hence facilitating timely responses. The integration of continuous decision-making support with instructional resources into an intuitive dashboard enhances the system's capabilities, rendering it indispensable for contemporary educational institutions. The automation of administrative tasks enhances student management, educational engagement, and academic performance, resulting in a contemporary educational environment that is responsive and efficient. Research will concentrate on employing advanced AI models to enhance predictive results while conducting comprehensive evaluations of student behaviour through various data inputs. The advanced system's real-time emotion recognition via facial expressions can yield profound insights into pupil engagement. Mystic learning algorithms integrated into the system will ensure continuous improvement and scalability across many educational contexts.

REFERENCES

[1] Chu, B. C., Guarino, D., Mele, C., O'Connell, J., & Coto, P. (2019). Developing an online early detection system for school attendance problems: results from a research-community partnership. Cognitive and Behavioral Practice, 26(1), 35-45.

[2] Adeniji, V. O., Scott, M. S., & Phumzile, N. (2016, May). Development of an online biometric-enabled class attendance register system. In 2016 IST-Africa Week Conference (pp. 1-8). IEEE.

[3] Obasi, N., Nwachukwu, E. O., & Ugwu, C. (2013). A Novel Web- Based Student Academic Records Information System. West African Journal of Industrial and Academic Research, 7(1), 31-47.

[4] Rahim, S. K. N. A., Ismail, N. R. P., Razak, F. A., Zulkifli, I. Z., Jamian, N. H., Razi, N. F., & Mohammad, N. H. (2017). Automated attendance management and alert system. Journal of Fundamental and Applied Sciences, 9(6S), 59-80.

[5] Paul, N. O., & Cornelius, N. U. Design and Implementation of Student Registration Attendance Management System Using Biometric (A Case Study Computer Science Department) Enugu State University of Science and Technology (ESUT).

[6] MITRA, A. R., LUKAS, S., DESANTI, R. I., & KRISNADI, D. (2017). Automated Student Attendance Management System Using Multiple Facial Images. DEStech Transactions on Computer Science and Engineering cmsam.

[7] Chen, D., & Xu, F. (2024). Design and implementation of machine learning algorithms in automatic grading of students' assignments. Journal of Electrical Systems, 20(3s), 899-919.

[8] Sulla-Torres, D. Development of a mobile application for the registration and control of attendance of university students based on Machine Learning.

[9] Heckman, S., & King, J. (2018, February). Developing software engineering skills using real tools for automated grading. In Proceedings of the 49th ACM technical symposium on computer science education (pp. 794-799).

[10] Tayong, A. A. New Optimization/ Automation Models for Hei Managerial Work: Grading, Registering Attendance, Examination Scheduling, Archiving, and Time tabling.

[11] Menezes, A. G., Sá, J. M. D. C., Llapa, E., & Estombelo-Montesco, C. A. (2020, July). Automatic attendance management system based on deep one-shot learning. In 2020 International Conference on Systems, Signals and Image Processing (IWSSIP) (pp. 137-142). IEEE.

[12] Kabir, M. H., Roy, S., Ahmed, M. T., & Alam, M. (2021). Smart attendance and leave management system using fingerprint recognition for students and employees in academic institute. International Journal of Scientific & Technology Research, 10(6), 268-276.

[13] Gajra, V., Lakdawala, K., Bhanushali, R., & Patil, S. (2020, April). Automating student management system using ChatBot and RPA technology. In Proceedings of the 3rd International Conference on Advances in Science & Technology (ICAST).

[14] Muhamadi, I. A., Zaidan, A. A., Raviraja, S., Zaidan, M. A., Zaidan, B. B., & Mapundu, C. (2009). Auto notification service for the student record retrieval system using short message service (SMS). International Journal of Computer Science and Network Security (IJCSNS), 9(8), 200-208.

[15] James, A. (2014). Automated students result management system using Oracle's database, forms and reports. Journal of Information Engineering and Applications, 4(11), 1-11.

[16] Subbiah, K. V., Dinesh, D., & Suresh, C. (2016). Development of a student database management system for a university. Int. Journal of Engineering Research and Application, 6(8), 16-24.

[17] Ayanlowo, K., Shoewu, O., Olatinwo, S. O., Omitola, O. O., & Babalola, D. D. (2014). Development of an automated hostel facility management system. Journal of Science and Engineering, 5(1), 01-10.

[18] Salim, O. A. R., Olanrewaju, R. F., & Balogun, W. A. (2018, September). Class attendance management system using face recognition. In 2018 7th International conference on computer and communication engineering (ICCCE) (pp. 93-98). IEEE.

[19] Werghi, N., & Kamoun, F. K. (2010). A decision-tree-based system for student academic advising and planning in information systems programmes. International Journal of Business Information Systems, 5(1), 1-18.