

An Automated Solution for Department Data Management System

Mr. Piyush Terkar

Mr. Kedar Khedkar

Department Of Information Technology,
MMCOE, Pune

Department Of Information Technology,
MMCOE, Pune

Ms. Mitali Chougule

Mr. Saurabh Lohokare

Department Of Information Technology
MMCOE, Pune

Department Of Information Technology
MMCOE, Pune

Dr. Rupali Chopade

Department Of Information Technology
MMCOE, Pune

Abstract—Department Data Management System (DDMS) is a software system designed to facilitate data management in a college department. The data includes attendance data, student data, student marks, and university data. The system also implements the functionality to map student university seat nos. The software automatically maps student attendance, generates academic reports and maps Course Outcomes (CO), and Program Outcomes (PO) to the result. Timely notification of attendance is provided to the respective students as well as their parents including insights and analysis of performance for students and faculties alike. The software is made available on all major operating systems like Android, iOS, Web, Windows, macOS, and Linux (all major distros), using a Progressive Web App (PWA). The user can extract data from uploaded documents regardless of whether they are in .csv, .xlsx, or .pdf (scanned or textual) format. In this application software, most of the manual tasks are automated, and data is accessible in a secure and timely manner, while maintaining a higher level of accuracy. The system is highly protected from most cyber attacks to maintain data privacy. DDMS offers a streamlined and efficient approach towards data management in various universities.

Index Terms—Database management, CO-PO mapping, Attendance monitoring, Data extraction, Optical character recognition (OCR), Progressive web app.

I. INTRODUCTION

In today's technologically advanced era, effective data management systems play a pivotal role in various domains. This article presents the Department Data Management System (DDMS), a software solution designed to streamline data management within college departments. DDMS offers a wide range of capabilities, including the management of university data, student data, student marks, and attendance data. It also includes the functionality to map students' university seat numbers to the respective academic records, automate attendance tracking, generate marksheets and map Course Outcomes (CO) and Program Outcomes (PO) to the final results.

The system is developed to cater to the needs of college departments, ensuring timely notifications of attendance to students and their parents, *result mapping* with respect to university records and providing valuable insights and performance analysis for both students and faculty. Furthermore,

DDMS is designed to work seamlessly on various operating systems including Android, iOS, Web, Windows, macOS, and Linux, using a *Progressive Web App (PWA)*. This cross-platform compatibility enables widespread accessibility and ease of use for all stakeholders involved.

One of the notable advantages of DDMS is its ability to extract data from diverse file formats such as .csv, .xlsx, and even scanned or textual .pdf files. This feature eliminates the need for manual data entry and enhances data accuracy and efficiency. Additionally, DDMS prioritizes data security, implementing robust measures to protect against cyber attacks and ensuring the privacy of sensitive information.

This article aims to provide an in-depth exploration of DDMS, its implementation, and the benefits it offers. The following sections dive into the system architecture, functionalities, data extraction capabilities, accessibility and compatibility aspects. Furthermore, the paper will discuss the system's deployment process, user experience, and the impact it has made in a real-world college department setting. Finally, the paper will conclude with a discussion on the limitations, future enhancements, and potential areas of expansion for DDMS.

II. BACKGROUND AND RELATED WORK

In colleges, the process of taking attendance during lectures can be time-consuming, particularly when dealing with large class sizes. Faculty members are required to conduct roll call once or twice per lecture, leading to a significant accumulation of time spent on this task. The traditional methods of attendance such as manual roll call or passing around a sheet

for students to sign, are not only time-consuming but also vulnerable to manipulation, allowing students to proxy for one another. [1-3] Furthermore, the manual calculation of marks for various assessments, including unit tests, midterm examinations, semester end examinations, practicals and vivas along with the mapping of roll numbers to exam seat numbers adds to the tedious workload of faculty members[2]. These challenges call for the development of a smart, efficient, and reliable attendance and data management system.

Several existing systems and technologies have attempted to address the issues faced in college attendance and data management. However, most of these solutions are either limited in functionality or lack the comprehensiveness required to meet the specific needs of college departments[3].

Some existing attendance systems rely on *physical biometric devices*, such as fingerprint or facial recognition scanners, an

improved attendance tracking, while these systems are often infrastructure and may not provide additional data management functionalities beyond attendance tracking[2-3].

Other systems focus solely on data management, such as *Student Information Systems (SIS)* or *Learning Management Systems (LMS)*[1]. These systems handle student records, course registrations, and assignment submissions but may not provide dedicated features for attendance tracking or mark calculation[3].

There are also mobile applications available for attendance management which utilize smartphone GPS or QR code scanning. However, these solutions often lack robust data management capabilities and may not integrate well with existing college systems[3].

By considering the limitations of existing solutions and leveraging the chosen technologies, the systems aims to overcome the challenges faced in college attendance tracking and data management. It strives to provide a reliable, user-friendly, and all-encompassing system that automates manual tasks, improves efficiency, and enhances the overall academic experience for both students and faculty.

III. SYSTEM OVERVIEW

A. System Architecture

In the case of our system, the chosen technologies for development are *ReactJS* for the Frontend, *ExpressJS* for the Backend and *MySQL* as the database. These technologies provide a solid foundation for building a scalable and responsive software solution that can run on various operating systems, including Android, iOS, Web, Windows, macOS, and Linux. In Fig. 1 the high-level system architectures comprises of a simple *client-server architecture*. The clients are broadly classified in a *Frontend Progressive Web App* which allows the app to be run as a normal web app and at the same data

time allows the application to be run natively on desktop and mobile operating systems. The server consists of various *microservices* where each service implements only a specific set of functionalities. This enables ease of development, while also making the system scalable and upgradeable. The clients communicate to the servers using a *Representational State*

Transfer Application Programming Interface (RESTful API) service. To ensure the security of data and overall system security, each request is passed through a set of stringent security checks, and allowed to proceed only if it passes these checks else it is rejected.

The API server is nothing but a request routing mechanism that routes the requests according to their context. The computational unit is responsible for all the data-heavy tasks, as extracting data, mapping seat numbers, generating reports, analyzing attendance, handling uploaded files, generating files to send as a downloadable attachment, etc.

Lastly, the entire data is maintained in a *Relational Database management system (RDBMS)*. Before carrying out any operation on the database, the request goes through a final set of security rules and constraints. The results of the appropriate requests are then sent back to the client as

HTTP response.

IV. SYSTEM IMPLEMENTATION

The implementation of the Department Data Management System (DDMS) involved the development of a robust software solution that automates various manual tasks and ensures secure and timely data accessibility. This section provides an overview of the system implementation process, including the development approach, data extraction capabilities, and data security measures.

A. Progressive Web App (PWA) Development

The DDMS was designed as a PWA to ensure compatibility and accessibility across multiple platforms, including Android, iOS, Web, Windows, macOS, and Linux (all major distros). This approach allowed users to access the system seamlessly from their preferred devices without the need for platform-specific applications.

The PWA development involved leveraging modern web technologies such as JavaScript frameworks like *ReactJS*. By employing responsive design principles, the user interface of the DDMS is optimized for different screen sizes, ensuring a consistent and user-friendly experience across devices.

B. Data Extraction using Tesseract Optical Character Recognition(OCR)

Tesseract OCR is a widely recognized open-source OCR engine developed by *Google*. Document segmentation is a major pre-processing phase in implementing an OCR system [6] It is renowned for its accuracy and versatility in converting images or scanned documents into editable and searchable text[5]. In the context of the Department Data Management System (DDMS), the integration of *Tesseract OCR* serves as a crucial component for automating the extraction of

from uploaded PDF files[6-8]. Tesseract uses its dictionary to influence the character segmentation step, for improved accuracy. [8]This functionality enables administrators and faculty members to effortlessly import relevant information into the system, eliminating the need for manual data entry.

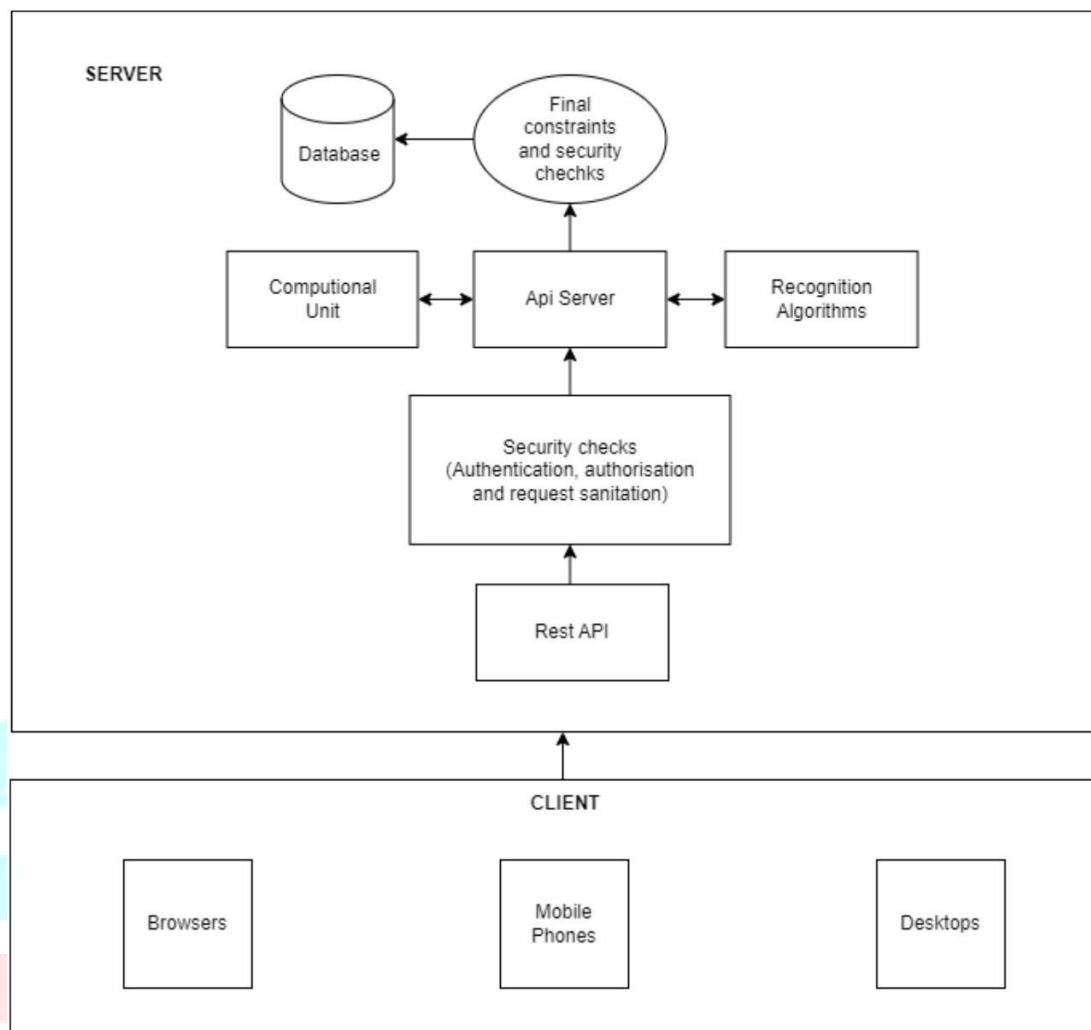


Fig. 1: System Architecture

The users upload the .pdf files from relevant data sources. The files are then converted to image format which is required by Tesseract OCR for pre-processing purposes. *Tesseract OCR* engine is applied to the pre-processed documents, performing intelligent character recognition and extracting textual information [5-8]. The extracted text is parsed and mapped to the appropriate data fields within DDMS, such as Attendance Data, Student Data, Student Marks, and University Data. The extracted data is seamlessly integrated into the existing database, ensuring its availability for further analysis and processing.

C. Automation of Manual Tasks

One of the primary goals of the DDMS is to automate time-consuming manual tasks related to data management. The system incorporated advanced algorithms and techniques to streamline processes such as attendance management, term work marksheet generation and result mapping. For attendance management, DDMS has a secure attendance module which facilitates attendance marking. This information is then promptly communicated to both the respective stu-

dents and their parents through timely notifications, ensuring transparency and accountability.

To generate academic reports of marks, the DDMS employed an algorithm that considered factors such as class participation, assignments, and project submissions. This automated process reduced the administrative burden on faculty members while maintaining consistency and fairness in the evaluation process.

Additionally, the system implemented intelligent *mapping of Course Outcomes (CO) and Program Outcomes (PO)* to the final result. By analyzing student performance and aligning it with predefined learning outcomes, the DDMS provided valuable insights into the effectiveness of the curriculum and educational programs.

D. Data Security Measures

Maintaining data privacy and protecting against cyber attacks were critical considerations in the implementation of DDMS. Robust security measures are implemented to ensure the confidentiality, integrity, and availability of the stored data.

To safeguard against cyber threats, DDMS incorporated multiple layers of security controls, including encryption tech-

niques for data transmission and storage. Secure authentication mechanisms, such as password-based or multi-factor authentication, are employed to restrict unauthorized access to the system.

Regular security audits and vulnerability assessments are conducted to identify and address potential weaknesses. The system is designed to adhere to industry best practices and compliance standards, such as the *General Data Protection Regulation* (GDPR) and other relevant regulations, to safeguard sensitive information and protect the privacy of students and faculty [4].

In addition, the system includes features to prevent data loss or corruption. Regular backups are performed to ensure data availability in the event of system failures or unforeseen incidents. Access controls and permissions were implemented to restrict data manipulation to authorized personnel only.

V. FUNCTIONALITIES

DDMS offers a range of essential functionalities tailored to meet the specific data management requirements of college departments. These include:

A. Attendance Data Management

The system provides tools for efficiently capturing and managing attendance data. It automates the process of tracking student attendance, generating timely notifications to students and parents, and maintaining comprehensive records for future reference [2].

B. Student Data Management

DDMS allows for centralized storage and management of student data. It encompasses functionalities such as student information updates, enrollment details, and easy retrieval of student records, ensuring that accurate and up-to-date information is readily available[4].

C. Student Marks Management

The software facilitates the automated calculation and recording of student marks, reducing the manual effort required by faculty members. It streamlines the process of assigning term work marks, ensuring accuracy and consistency in assessment. Promoting students to the next semester based on marks is also an important functionality [4].

D. Mapping Student University Seat Numbers

As most academic records that are formatted by the university are in alphabetical order of student names, it becomes a tedious task to map the university seat numbers to the college database. The project includes a feature for accuracy mapping student university seat numbers to college assigned roll numbers, simplifying the identification and tracking of individual students across various administrative processes.

This research is a significant contribution to the field of data organization and

E. Data Extraction and Formats

DDMS supports the extraction of data from diverse document formats, including .csv, .xlsx, and even scanned or textual .pdf files. This flexibility allows for easy data importation from various sources, ensuring compatibility and reducing manual data entry efforts. The process of data extraction uses Tesseract OCR [7-8].

F. Accessibility and Compatibility

DDMS is designed to be accessible across multiple platforms and operating systems, including Android, iOS, Web, Windows, macOS, and Linux (across various distributions). The software utilizes a Progressive Web App (PWA) framework, enabling users to access the system through web browsers without the need for platform-specific installations. This cross-platform compatibility ensures widespread availability and ease of access for users.

VI. USER EXPERIENCE

A. Timely Notifications and Communication

The Department Data Management System (DDMS) offers a seamless experience for students, parents and faculty by providing timely notifications of attendance. Students and parents receive alerts regarding attendance status, ensuring they stay informed about their academic progress. This feature enhances communication between all stakeholders, facilitating prompt action and intervention when necessary [2].

B. Result Mapping and Analysis

DDMS automates the process of mapping Course Outcomes (CO) and Program Outcomes (PO) to student results. This functionality enables efficient assessment and evaluation of student performance. Faculty members can easily analyze and interpret the results, gaining valuable insights into individual student progress and overall class performance. Such data-driven analysis helps identify areas for improvement and enables evidence-based decision-making in curriculum development.

C. Performance Insights for Students and Faculty

The system empowers both students and faculty by providing comprehensive performance insights. Students can track their attendance records, academic records, and mapped outcomes, allowing them to monitor their academic progress and identify areas that require attention. Faculty members gain access to detailed performance data, enabling personalized guidance and support for students. This feature fosters a collaborative learning environment and improves overall academic outcomes [4].

D. Enhanced Accuracy and Efficiency

By automating manual tasks, DDMS significantly reduces the risk of human error and ensures a higher level of

in data management. The system eliminates the need for manual data entry, as it can extract data from various formats including .csv, .xlsx and scanned or textual .pdf files. This automation of data entry improves efficiency, and minimizes the

VII. DISCUSSION AND FUTURE WORK

A. System Limitations and Challenges

Despite the numerous benefits and functionalities offered by the Department Data Management System (DDMS), there are a few limitations and challenges that should be addressed. One limitation is the reliance on uploaded documents for data extraction, which may be time-consuming and prone to errors if the documents are not in a standardized format. Additionally, the system may face compatibility issues with certain operating systems or devices, requiring further optimization and development. Another challenge is ensuring the system's scalability to accommodate a growing number of students and faculty members while maintaining optimal performance.

B. Future Enhancements and Expansions

The future work proposed for the system aims to build upon the existing foundation and extend the system's functionalities. By incorporating advanced data analysis techniques, integrating with existing learning management systems, enhancing the mobile application, exploring biometric attendance integration, providing a feedback and communication module, integrating with online examination platforms, optimizing scalability and performance, ensuring data security, and improving the user interface, the project aims to create a comprehensive and efficient solution for college department data management. To further improve the DDMS and provide a more comprehensive data management solution, several areas can be explored for future enhancements and expansions.

C. Integration with Learning Management Systems (LMS)

Integrating the DDMS with a Learning Management System would allow for seamless synchronization of student data, course content and assessments[4]. This integration could provide a more holistic view of student performance, enable automated grade updates, facilitate a streamlined communication channel between students, faculty, and administrators.

D. Predictive Analytics and Performance Insights

Implementing predictive analytics algorithms and data visualization techniques can provide valuable insights into student performance trends, helping identify at-risk students and areas where instructional interventions may be necessary. By leveraging historical data and machine learning models, the system can generate predictive analytics reports, empowering faculty members to make data-driven decisions to enhance teaching strategies and student success rates.

VIII. CONCLUSION

The Department Data Management System (DDMS) presented in this article offers an automated and secure solution for managing various types of data in a college department. By addressing the challenges associated with data management, the system streamlines administrative tasks, enhances accuracy, and ensures timely access to information for both students and faculty. One of the key advantages of DDMS is

its ability to provide timely notifications to students and their parents regarding attendance and other important updates. Data security and privacy are critical considerations in any data management system, and DDMS addresses these concerns robustly. The implementation includes cybersecurity measures that protect against potential threats and maintain the confidentiality and integrity of data. By ensuring data privacy, the system instills confidence among users regarding the protection of sensitive information.

The successful deployment of DDMS in a college department has validated its viability as a practical solution for data management. User feedback has been positive, highlighting the system's user-friendly interface, reliability, and improved efficiency.

The system automates manual tasks such as attendance tracking, academic performance generation, and result mapping, reducing the burden on administrative staff and minimizing the chances of errors. Furthermore, the software's compatibility with multiple operating systems and support for various file formats enable seamless data extraction and accessibility.

In conclusion, the Department Data Management System (DDMS) offers a comprehensive and efficient solution for managing data in a college department. With its automated processes, secure environment, and user-friendly interface, DDMS has the potential to revolutionize data management practices, enhance decision-making, and improve overall efficiency in educational institutions.

CONFLICT OF INTEREST

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome. We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us. We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing, we confirm that we have followed the regulations of our institutions concerning intellectual property.

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