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"Smart Occupancy Monitoring and Crowd Density Visualization System."

Dr. P.B. Kumbharkar
Department of Computer Engineering
JSPM's Rajarshi Shahu College of Engineering
Pune-411033, Maharashtra, India

Samir Asawale
Department of Computer Engineering
JSPM's Rajarshi Shahu College of Engineering
Pune-411033,
Maharashtra,India

Vishal Biradar
Department of Computer Engineering
JSPM's Rajarshi Shahu College of Engineering
Pune-411033,
Maharashtra,India

Shivam Kapdia
Department of Computer Engineering,
JSPM's Rajarshi Shahu College of Engineering, Tathwade
Pune-411033, Maharashtra,India

Dheemahi Gupta
Department of Computer Engineering
JSPM's Rajarshi Shahu College of Engineering
Pune-411033, Maharashtra,India

Abstract-The growing demand for real-time operational insights and resource optimization in healthcare and public spaces highlights the need for advanced machine learning solutions. This project employs the YOLO (You Only Look Once) technique for real-time crowd density analysis, operational status detection, and predictive analytics. The system provides real-time bed availability and vacancy status across hospitals, enabling efficient appointment scheduling. Additionally, it evaluates destinations such as hotels, shopping malls, and restaurants, offering insights into operational status (open/closed), crowd density, and occupancy levels. By leveraging YOLO's robust object detection capabilities and integrating predictive analytics, the system aims to enhance user decision-making and streamline resource utilization in diverse environments. This approach demonstrates the potential of AI-driven solutions in addressing modern societal challenges, promoting efficiency, and enhancing the user experience.

Keywords:Real-time insights, resource optimization, machine learning solutions, YOLO, crowd density analysis, operational status, predictive analytics, bed availability, appointment scheduling, object detection, healthcare resource management, public space analysis, user decision-making, efficiency enhancement.

I. INTRODUCTION

In today's fast-paced world, real-time information and efficient resource management are critical, especially in healthcare and public spaces. The growing population and demand for immediate access to services necessitate advanced solutions for better decision-making and optimized operations. This project leverages the YOLO (You Only Look Once) technique, a state-of-the art machine learning model, to address these challenges by performing real-time crowd density analysis, operational status detection, and predictive analytics

The system primarily focuses on healthcare facilities, providing real-time insights into bed availability and vacancy status, thus enabling seamless appointment scheduling. Additionally, it extends its application to public spaces such as hotels, shopping malls, and restaurants, offering comprehensive data on operational status, occupancy, and crowd density. By utilizing the robust object detection capabilities of YOLO and integrating predictive analytics, the project ensures accurate and timely information delivery

This innovative approach not only enhances user decision-making but also hlps businesses and institutions streamline their operations. By addressing key societal challenges through artintelligence, the project underscores the potential of machine learning in creating smarter, more efficient environments.

In the healthcare domain, the system provides up to-date information on bed availability and

vacancy status, enabling users to book appointments with ease and confidence. Extending its application to public venues, the system offers insights into operationalcupancy rates, empowering both users and businesses to make informed decisions.

By combining this robust technology with predictive analytics, the project ensures that users not only receive current data but can also anticipate trends and optimize their actions accordingly. This AI-driven solution addresses modern societal challenges by promoting efficiency, enhancing user experiences, and supporting smarter decision-making across diverse environments. Ultimately, this project showcases the transformative potential of machine learning in solving real-world problems and improving quality of life.

II. LITERATURE SURVEY

1..Jiwei Chen, Su Wen and Zengfu Wang:Crowd counting with crowd attention convolutional neural network: IEEE-2022 :Proposes an end-to end crowd counting model called CAT-CNN. The model uses a weighted BCELoss function to generate a robust confidence map for population distribution.

2.Ms. Subashree D, Shrushti Rohidas Mhaske, Sonal Rajesh Yeshwantrao, Ayush Kumar:Real Time Crowd Counting using OpenCV:IEEE 2021: A people counter system was developed using OpenCV and Python. It can be improved by calculating distances between bounding boxes.

3.Meygen Cruz, Jefferson James Keh, Ramiel Deticio, Carl Vincent Tan, John Anthony Jose, Elmer Dadios:A People Counting System for Use in CCTV Cameras in Retail:IEEE-2020: A people counting system was developed using CCTV footage, achieving 66.17% accuracy

4.Jun Zhang, Jiaze Liu and Zhizhong Wang:Convolutional Neural Network for Crowd Counting on Metro Platforms:IEEE-2021: Proposes a novel method, MP-CNN, for counting people in crowds on metro platforms. The method uses a multiscale feature extraction module (MFEM) to address occlusion and varying head sizes.

5.A HOSPITAL BED AVAILABILITY MONITORING SYSTEM USING THE INTERNET OF THINGS: International Journal on Information Technologies & Security, № 3 (vol. 16), 2024 : The study presents an IoT-based monitoring system for hospital bed availability, designed to address shortages. It utilizes optical sensors for accurate data collection, facilitating web and desktop access for users and hospital staff.

6.The Hospital Management System International Journal of Engineering and Management Research e-ISSN: 2250-0758 | p ISSN: 2394-6962 Volume-12, Issue-5 (October 2022): The proposed hospital management system is a web-based application designed to streamline hospital operations, including patient registration, appointment scheduling.

7.Hospital Adoption of API-Enabled Patient Data Access ,2019 December : The study by Holmgren and Apathy examines hospital adoption of API enabled patient data access across the U.S. healthcare system. Despite significant advancements in electronic health record (EHR) adoption, patient access to health data remains limited.

III. PROPOSED SYSTEM

The proposed system utilizes the YOLO (You Only Look Once) technique for real-time object detection and predictive analytics. The main aim of this proposal is to furnish actionable insight for resource management and decision-making in healthcare facilities and public areas. The system has been customized with multiple modules so that they can successfully handle their real-time crowd density analysis, operational status detection, and resource vacancy monitoring features. However, from the perspective of the healthcare domain, the system furnishes real-time availability and vacancy status of hospital beds across hospitals. This kind of information assists a user in locating and reserving hospital beds with minimal delay during the crucial time factor.

The system uses predictive analytics for forecasting trends of bed occupancy to better meet resource management and operation planning within hospitals. It comprises the online venues, including hotels, shopping malls, and restaurants, and gives an update in real-time on the operational status (open/closed), total capacity, current occupancy, and crowd density %age of each such place. Such information helps people in deciding about visiting these places without discomfort or fear. The users become informed, while businesses can leverage these insights toward betterment of their operating models.

3.1 Methodologies :

3.1.1.Requirement Gathering: The first step in implementing the system is understanding user requirements through collaboration with stakeholders like hospital administrators, hotel managers, and public space authorities. This involves identifying challenges they face, such as delays in accessing healthcare resources or managing crowd density effectively. The primary needs include real-time updates on hospital bed availability and operational data for public spaces.

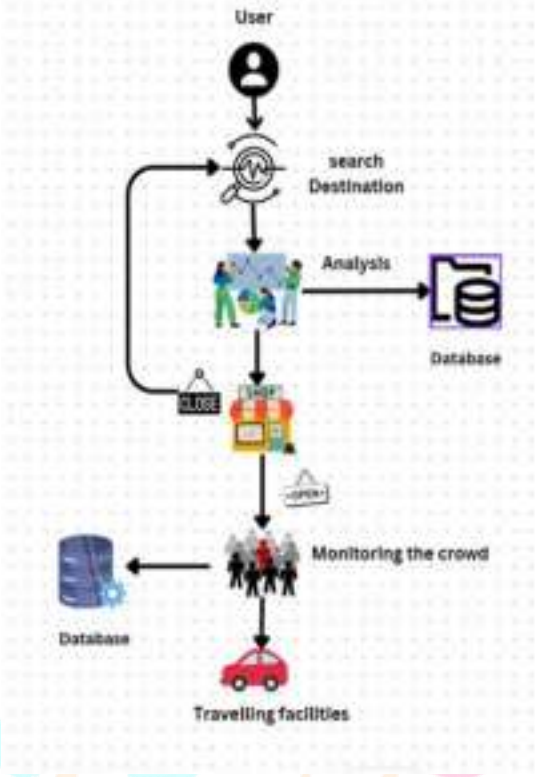
These requirements ensure that the system is tailored to address overcrowding and improve

resource utilization. Stakeholders also emphasize the importance of easy-to-use interfaces for quick decision-making. Additionally, it is vital to determine the technical specifications, such as data sources, hardware capabilities, and network infrastructure.

Analysing competitors' solutions and feedback from end-users can further refine the requirements. The gathered data lays the foundation for designing a system that aligns with real-world needs. Clear documentation of requirements ensures that development proceeds in a structured manner, minimizing ambiguities.

3.1.2. Planning and Design :

The selecting of appropriate technologies for creating an extensible, secure, and effective system falls under the planning phase. Node.js with express.js is selected for backend data operations while computer vision algorithms are applied under person detection using Python Flask for that intervention. Create an application with the use of React to provide interactive and responsive user interface. The application would use MongoDB as the database management system under MERN for large dataset processing and will have an SQLite integration for the Python-based detection application. In a well-structured modular architecture, the Flask-based analytics, as part of the whole MERN stack, blend in nicely. Design goal specifications are scalability to address the increase in amounts of data, security, and user-friendliness, all to ensure adoption. The detailed diagrams of workflows, APIs, and system components will guide the development.



The planning phase involves using technologies to build a scalable and secure as well as efficient system. Node.js with express.js handles backend data operations, while computer vision algorithms for person detection will work using Python Flask. An application of these is through React, building an interactive and responsive user interface. The application uses MongoDB as the database management system to process large datasets under MERN, with an SQLite level integration for the Python-based detection application. This sets up a modular architecture into which the Flask-based analytics would be wove and integrated within MERN. Design goals include focus toward scalability as an increase in amount of data would be expected, security in terms of expensive-sensitive information, and user-friendly approaches toward acceptance by system users. Guided by detailed drawings of workflows, APIs, and system components, development will then occur. This phase secures a coherent structure, which will make the future improvement or change in the system possible. Wireframes and prototypes meet the sharing of stakeholders to get confirmation if we are on the right track or not.

3.1.3.Development :

System construction and integration into a coherent whole occurs. Hospital data such as bed availability and operational state management has to be carried out through the Express.js APIs in the MERN project. 1. This will provide users

access to a real time dashboard from the React front end that will visualize all of this data dynamically. 2. This information is stored in MongoDB, which gives reliability and scalability for large datasets. In 3. The CCTV feeds will be used in the Python Flask application that has YOLOv8 implemented to identify individuals and analyze crowd density. 4. Threading will also be used to process real-time data well without having bottlenecks in the system. 5. APIs are developed to connect Flask based analytics to the MERN dashboard ensuring seamless data flow. The live updates are made possible through the WebSocket connection, thus keeping the data synchronized among all components. Each module is tested during development to ensure performance and functionality meet the expectations. Continuous integration (CI/CD) practices are observed such that changes made in the codebase do not disrupt the overall functionality of the system

3.1.4.Functionalities :

It consist strong functionalities to display real-time resource availability and crowd density monitoring. Algorithms powered by YOLOv8 are used to analyse video footage from CCTVs to determine the degree of crowdedness in public places, thereby giving raise to the optimistic prevention of overcrowding. The hospital module will always show real-time bed availability property and operation state, whereby both patients and staff will know the right thing to do and act quickly. React-based dashboard to display this information has been created to be intuitive and attractive, accommodating filtering and sorting options for better usability. All these ensure real-time updating without the page refresh in a picture shown. The APIs link Python Flask analytics to the MERN stack in ensuring cross-system data sharing. Users shall always enjoy the benefit of interacting with the system through a responsive front end, fit for any device such as smartphone and desktop. Alerts and notification are embedded to prompt actions in time. All these comprise a complete solution that attends healthcare and public spaces. Updates are frequent to keep the system optimally efficient and relevant.

3.2 System Design :

1.Login and Registration Module :

The Login and Registration Module ensures secure authentication and authorization for admins and users. Admins must log in using their credentials, while users can browse without registration. The module also provides separate forms for hospitals and restaurants, requiring hospital and restaurant details. Input fields are validated for accuracy, and the system generates a unique ID for each entity and activates admin accounts upon successful registration.

2.Application Dashboard :

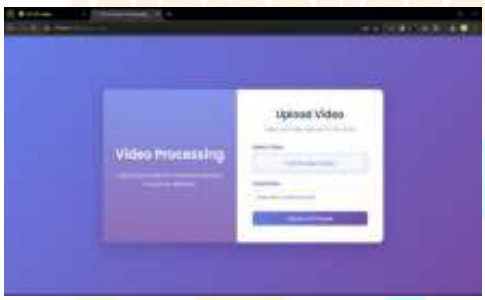
The application dashboard is a control panel for hospital and restaurant admins, offering tailored views based on their roles. It allows admins to manage hospital and restaurant data, add or edit hospital details, update real-time bed vacancy status, and manage multiple branches.

The Restaurant Admin Dashboard offers tools to manage restaurant details, upload AI-based crowd estimation videos, and update operational status. Users can search hospitals and restaurants by name or location, view key information, and refine results using filters. The AI model helps users find less crowded places for their visits.

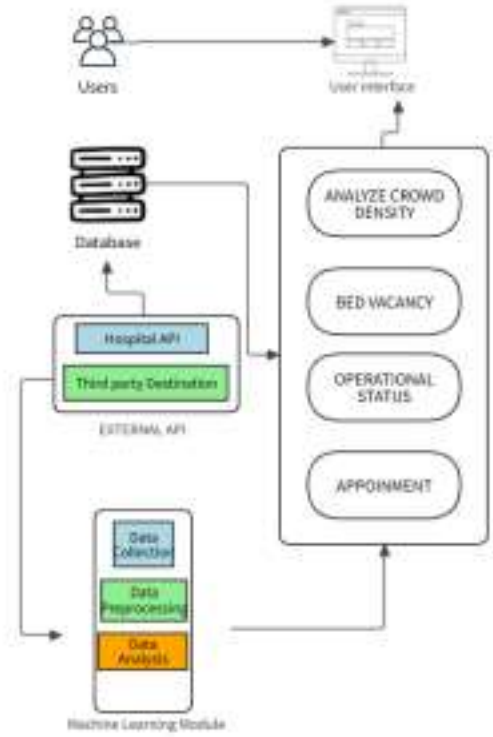
3.Hospital Module:

The Hospital Module allows administrators to register hospitals, update bed vacancy status, and send notifications for near-capacity alerts. Users can search hospitals by name or location and view detailed information, including real-time bed availability.

4.Restaurant Module:



Restaurant admins register and receive a unique ID, allowing them to upload video files for AI based crowd detection. Users can search for restaurants, view real-time crowd size, and filter for less-crowded places, while admins can edit information.



IV. RESULT AND OUTCOME

V. FUTURE SCOPE

Expanding the project to integrate with existing smart city platforms, such as traffic management systems, public transport networks, and emergency response systems. Introducing predictive analytics based on historical data and user patterns to predict future crowd density or the likelihood of a destination being open/closed.

Integrating social media platforms (e.g., Instagram, Twitter) to allow users to share their experiences and get crowd density data from other people in real-time.

Adding an AR-based navigation feature to guide users in real time through crowded spaces or toward less crowded areas.

VI. CONCLUSION

This project is a solution that integrates real-time crowd density analysis, destination status updates, and smart travel recommendations. Using YOLO for object detection, image processing, and real-time data, the system gives users information about crowd levels and the status of different destinations. It monitors crowd density and availability using CCTV camera feeds, improving the experience for users in places like cities and restaurants. The system also provides location-based services to assist the user in getting the best travel options. In healthcare, it tracks hospital bed availability and vacancy with that allows users to schedule appointments, improving resource management. Machine learning is used to make crowd detection accurate and scalable, which is useful in various sectors like healthcare, transportation, and retail.

Such enhancements in the near future can also be through introducing features like AR for navigation purposes, better prediction of crowd via AI tools, and more personal experience for the user. It may expand all around the globe according to various country-specific systems working together. This

Therefore, it addresses many problems regarding crowd management, service status updates, and travel optimization. That is its practical and scalable solution. In the final instance, it should make public spaces safer, more efficient, and easier to navigate.

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