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A Review on Hospital Seat Occupancy System

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A B S T R A C T

In the fast-paced realm of modern healthcare, effective resource allocation is crucial, especially within busy hospital settings. This surveillance system offers an innovative solution to tackle the complexities of managing crowds in hospitals. By harnessing cutting-edge surveillance technology and instant data analysis, the system improves patient satisfaction by alerting individuals to available seats in waiting areas, optimizing resource usage, and reducing inconvenience. With a focus on patient welfare, the system aids in the prudent allocation of healthcare resources. Equipping healthcare staff with real-time updates on seat occupancy, the system facilitates proactive measures, ensuring a smooth and orderly patient flow. It represents a groundbreaking approach to hospital crowd control, featuring real-time monitoring and communication capabilities. Through advanced image processing and machine learning, the system continuously tracks waiting area occupancy, promptly informing patients of vacant seats, thereby cutting wait times and enhancing overall contentment. Flexible resource allocation ensures patients are efficiently directed, benefiting both patients and healthcare institutions. With its comprehensive features, this healthcare resource management system addresses immediate crowd management challenges, positioning itself as a holistic solution to enhance patient experiences and overall operational efficiency in healthcare facilities.

Keywords: *crowd management, patient-centric, real-time insights, seat occupancy, surveillance technology.*

1. INTRODUCTION

Hospitals are critical institutions where timely access to medical care can be a matter of life and death. However, the healthcare sector often faces the challenge of overcrowding in waiting areas, leading to extended waiting times, patient discomfort, and operational inefficiencies. A sophisticated system that harnesses the power of CCTV surveillance, artificial intelligence, and real-time data processing to address the complexities of hospital crowd management needed to be introduced. The core functionality of these system lies in its ability to monitor the occupancy status of waiting areas continuously. In the rapidly evolving landscape of healthcare technology, the Seat Vacancy Detection System stands out as a revolutionary solution. This innovative system, designed to optimize resource allocation and enhance patient convenience, has proven to be a game-changer in the realm of healthcare service delivery. One of the standout features of the Seat Vacancy Detection System is its user-friendly interface. Using advanced image processing and machine learning algorithms, the system can detect when a seat becomes vacant and then triggers an automatic notification to alert waiting patients. This real-time communication enables patients to make informed decisions about where to sit, reducing stress and minimizing the perception of long wait times. Existing systems faces the challenges of students and librarian's in locating unoccupied seats, students, and details of seat occupants in the library are central to this research. Students place objects to occupy seat, as a form of impromptu reservations known as seat hogging [1]. Other system uses RFID sensor as an aspect to the vacancy detection however keeping real time surveillance technique have not been discovered by researchers and application had been varied in different sectors but in the major environment had yet to be explored. CCTV surveillance and RFID sensors are two distinct technologies with different strengths and applications. While both can be used for seat occupancy detection, each has its advantages and limitations. Those system which opted for RFID technology lacks the visual confirmation that a camera provides. Some may come across sensors as lower installation for a smaller number of seats it is preferable [7]. Cameras do have upfront cost and complex installation but they serve multiple purposes that are beyond seat occupancy detection. This visual distinction will allow viewers to ascertain the availability of seats quickly and easily within the monitored area, enhancing convenience and facilitating informed decision-making for occupants. As in past studies, the first approach uses face detection methods to perform front seat occupancy detection. The second approach uses a machine-learning based classifier that detects front seat occupancy by using a global image representation of the captured images. The choice between CCTV surveillance and RFID sensors should consider the specific needs of the application, balancing factors like coverage, cost, privacy, and scalability. Ultimately, the optimal solution may involve a combination of technologies to leverage their respective strengths.

2. REVIEW OF LITERATURE

The following chapter is a literature survey of the previous research papers and research which gives the detailed information about the previous system along with its advantages and disadvantages.

In a study conducted by Okoronkwo Chinomso Daniel, et.al [1], contemporary times, the Internet of Things (IoT) has profoundly influenced various facets of human existence and the surrounding environment. The IoT paradigm places a central emphasis on connecting virtually everything to the Internet, permeating diverse fields of study. This paper addresses a prevalent issue in library management: the efficient utilization of library seats. The paper introduces a comprehensive solution that amalgamates hardware and web applications, facilitating students and librarians in remotely verifying seat occupancy and the identity of seat occupants within the library via internet-enabled devices or display systems located at the library's entrance. their prototype, are of featuring pressure-sensitive (force-sensing resistor) and Radio Frequency Identification (RFID) sensors for monitoring library seat occupancy, has successfully addressed several challenges. These include curtailing seat hogging practices, reducing time wasted on the hunt for unoccupied seats, and minimizing disruptive phone calls made by students seeking the whereabouts of their peers within the library. This research entails the development of a functional prototype system that effectively measures seat occupancy in real-time and communicates this data to a web application.

In their research paper Michel Devy, et.al [2], Vision systems offer promising opportunities to enhance vehicle safety significantly. In particular, innovative methodologies are applied to the detection and classification of passenger seat occupancy, revolutionizing the control mechanisms for airbag deployment. In this research paper, we introduce a stereo vision system meticulously designed for observing the cockpit scene, with the primary objective of gathering data on passenger presence and their location within the vehicle cabin. Using the stereo data, we generate a comprehensive cockpit occupancy map. Their system is adept at recognizing various typical configurations of the passenger seat, including scenarios such as an empty seat, the presence of an adult, or the installation of a baby seat. The methodology involves an offline learning phase where a dataset of cockpit images is meticulously collected for each of the aforementioned seat situations. From these images, we extract discriminative attributes. Subsequently, we employ a case-based classification approach to determine the current seat configuration accurately. This research represents a significant step forward in harnessing vision systems for enhancing vehicle safety, Specifically, it focuses on enhancing the optimization of airbag deployment through real-time monitoring of passenger seat occupancy. By developing an efficient stereo vision system and a robust classification method, we aim to contribute to the improvement of vehicle safety measures, ensuring that airbags are deployed judiciously and in accordance with the specific passenger situation.

Boby George, et.al [3], proposed in this paper that they introduce a straightforward, yet highly effective seat occupancy detection system based on the principles of capacitive sensing. Accurate knowledge of parameters such as the presence, position, and type of occupant in a vehicle seat is crucial for optimizing airbag control mechanisms. Without this vital information, there is a risk of inflating airbags into empty seats (ES) during a collision, resulting in unnecessary repair and reinstallation costs. More critically, in the case of rear-facing infant seats, the inadvertent deployment of airbags can lead to severe and even fatal injuries to infants. they proposed capacitive sensor system that excels at detecting the presence of an occupant and precisely determining their position within the seat. We have developed a working prototype of this occupancy detection system and have validated its feasibility through practical testing. Remarkably, the system boasts a rapid measurement completion time of just 200 is, promising real-time functionality for airbag systems. The methodology presented in this paper relies on a carrier-frequency approach and leverages the lock-in-amplifier technique for capacitance measurements. This approach effectively minimizes the impact of external electromagnetic fields on the accuracy of the results. Overall, our system offers a robust solution to seat occupancy detection, contributing to enhanced safety in vehicles by ensuring that airbags are deployed with utmost precision and effectiveness.

Xinyu Wu, Xu et.al [4], proposed that an automated approach for the detection of abnormal crowd density, a crucial component of intelligent surveillance systems in public spaces. Leveraging texture analysis and learning, this method offers valuable insights for enhancing security and crowd management. To achieve accurate density estimation in crowded scenes, the technique employs a perspective projection model, generating a series of multi-resolution image cells. These cells are designed to improve the precision of density estimation. Notably, the cell sizes are normalized to ensure uniform representation of texture features. To mitigate the instability often associated with measuring texture features, the paper incorporates a method for identifying extrema in the Harris-Laplacian space. Texture feature vectors are extracted from each input image cell, and the support vector machine (SVM) is employed to address the regression problem, effectively calculating crowd density. Moreover, employing the estimated density vectors, the SVM method is once again employed to address the classification challenge associated with identifying abnormal density distributions. Real-world experiments conducted on crowd videos demonstrate the effectiveness and practicality of the proposed system. In sum, this method holds promise for significantly enhancing surveillance and security efforts in public spaces by providing a robust means of detecting abnormal crowd density patterns.

Beilei Xu Member, IEEE, et.al [5], conducted research to address the escalating traffic congestion on modern highways, transportation agencies have introduced dedicated managed lanes, permitting only vehicles with a specified occupancy level. This strategy aims to incentivize carpooling and, theoretically, enhance the efficiency of transporting individuals across the highway system. However, to implement this approach to be effective, strict adherence to the vehicle occupancy rules is much needed. Recent research has highlighted the limitations of the traditional method, involving traffic law enforcement officers performing roadside visual inspections, which is not only costly and hazardous but also ineffective for managed lane enforcement. Authors framed an image-based machine learning solution for automatic or semi-automatic vehicle occupancy detection. They proposed a method that focuses on localizing windshield regions by constructing an elastic deformation model based on sets of uniquely defined landmark points along the front windshield. By utilizing these localized windshield regions, their method derives image-level feature representations, which are subsequently employed by a trained classifier to categorize vehicles into either violator or non-violator classes. By implementing this innovative approach, to provide a more

efficient and cost-effective means of enforcing vehicle occupancy rules in managed lanes. This approach not only enhances safety and accuracy but also aligns with the evolving demands of modern transportation systems.

The proposed development by Yuhao Jing, et.al [6], introduces a comprehensive library seat management system designed to address seat occupancy challenges. The system leverages an Arduino single-chip microcomputer as its central data processing unit, equipped with various components including an information reading system, lock/unlock mechanism, information transmission system, and display system. Together, these components enable the collection and transmission of seat usage information within the library. By utilizing a serial port, the system seamlessly integrates data acquired from each subsystem. This data encompasses seat position information, card swiping records, and seat occupancy status. This aggregated information is then transmitted to an upper-level computer system, providing real-time feedback to administrators and facilitating effective seat management. Results from testing indicate that the system operates with stability and effectively manages seat vacancies. It successfully addresses issues related to unreasonable seat reservations and enhances seat utilization rates within the library environment. In conclusion, this system offers a reliable solution to optimize seat management, ultimately benefiting library patrons and administrators alike.

Poovizhi S, et.al [7], conducted extensive research on the railway system plays a pivotal role in the economic development of any country. In this context, this invention introduces a sensor system designed to serve two critical purposes: determining seat occupancy within a railway vehicle and monitoring water levels on the train. Ensuring a positive customer experience is paramount, and having knowledge of available or occupied seats is vital for passengers in making informed travel decisions. This innovative approach not only provides real-time detection of seat occupancy for every individual seat but also offers continuous updates on seat status. This real-time data can be conveniently displayed on a PC within the monitoring section, enhancing operational efficiency. Their system achieves seat occupancy detection by employing an array of infrared (IR) sensors, ensuring accuracy and reliability. In addition to seat occupancy, the system also monitors water levels within the train, utilizing a float water level sensor. Data collected from both seat occupancy and water level sensors is seamlessly transmitted via a wireless mesh sensor network, facilitated by UART (Universal Asynchronous Receiver Transmitter). This integrated approach represents a significant advancement in railway management, enhancing passenger experience by providing crucial information and contributing to the overall efficiency of train operations.

Yusuf Artan, et.al [8], performed an innovative approach in response to the escalating traffic volumes on contemporary roadways, transportation agencies have introduced High Occupancy Vehicle (HOV) lanes and High Occupancy Tolling (HOT) lanes to encourage carpooling. However, the enforcement of lane occupancy rules has traditionally relied on manual inspections by roadside enforcement officers, a method acknowledged for its inefficiency, high cost, potential danger, and overall ineffectiveness. Their reports have indicated violation rates ranging from 50% to as high as 80%, while manual enforcement rates typically remain below 10%. Hence, an immediate requirement exists for automated vehicle occupancy detection systems to strengthen HOV/HOT lane enforcement. A critical factor in determining vehicle occupancy involves evaluating the occupation of the front passenger seat. This study delves into two separate approaches for verifying front seat occupancy, utilizing a near-infrared (NIR) camera system strategically placed toward the vehicle's front windshield. The first method examines a cutting-edge deformable part model (DPM)-based face detection system, renowned for its robustness in handling various facial poses. The second method explores state-of-the-art local aggregation-based image classification techniques, employing the bag-of-visual-words (BOW) and Fisher vectors (FV) approaches.

Shengke Wang, et.al [9], proposed a framework addresses the challenge of accurately counting people in multi-camera surveillance systems with overlapping areas. The traditional calibration of cameras for overlapping regions is impractical for numerous cameras, so the authors propose using an image mosaic algorithm. Specifically, they focus on identifying repetitive individuals to enhance population statistics accuracy. The approach involves training a head detector for each camera, creating a database of head pairs, and employing Siamese networks for re-identification. The method aims to find recurring people across cameras and calculates the median of total people in all frames for accurate statistical results. The authors acknowledge the impact of head detection on accuracy and plan to enhance the matching process in future work.

In the study of Hongyu Liang, et.al [10], Accurately counting people in seats is of paramount importance for effective surveillance, but it presents a formidable challenge due to the diverse appearances of individuals and the presence of various outliers like bags and clothing. To address this complex problem, we introduce a comprehensive coarse-to-fine framework. Our approach begins with a coarse classification module, which serves to identify completely empty seats. To mitigate the impact of noise caused by factors such as shadows and light spots, we harness the power of multiple global features computed through background subtraction. Subsequently, in the fine classification module, we employ a novel SW-HOG feature in conjunction with the LBP feature. This combination helps overcome challenges related to occlusion and ensures real-time classification. Furthermore, we implement a time-related calibration module to effectively suppress outliers that may emerge across frames, with the condition that video frames are not necessarily consecutive. Experimental results conducted on a real dataset from meetings underscore the robustness of our proposed method, achieving an impressive accuracy rate of 99.88%. This research offers a significant advancement in the realm of people counting within seats, greatly enhancing the precision and efficiency of surveillance systems.

David Beyme [11], conducted study on stores and shopping malls have a vested interest in accurately monitoring shopper traffic through automated means. Conventional methods involve the installation of infrared beams at entrances to count shoppers by tracking interruptions in these beams. However, this approach falls short in effectively distinguishing groups of people. In response, we have implemented a vision-based solution utilizing stereo cameras mounted above doorways and angled downward. This system leverages real-time stereo vision and 3D reconstruction to segment the scene, specifically focusing on stereo pixels within a 3D volume of interest. This volume is strategically positioned to capture the heads and torsos of adult shoppers. This approach introduces two significant innovations: 1. Transforming stereo disparities into an orthographic "occupancy map" simplifies the modelling of individuals. 2. Tracking people using a Gaussian mixture model, enhancing the accuracy of shopper counting. In rigorous testing, involving 900 entry and exit events observed over 4 hours of video footage, our system demonstrated exceptional performance, achieving a mere 1.4% net counting error

rate. This research represents a substantial advancement in automated shopper counting systems, providing an accurate and reliable means of tracking shopper volume in stores and malls.

Tao Zhao et.al [12], emphasizes their work on the problem of segmenting individual humans in crowded situations from stationary video camera sequences is exacerbated by object inter-occlusion. He poses this problem as a "model-based segmentation" problem in which human shape models are used to interpret the foreground in a Bayesian framework. The solution is obtained by using an efficient Markov chain Monte Carlo (MCMC) method which uses do main knowledge as proposal probabilities. A theoretically sound framework integrates knowledge from various aspects, encompassing human shape, human height, camera model, and image cues such as human head candidates and foreground/background separation. The work described by the author here could be improved or extended in several ways. Currently the likelihood is based only on a binary foreground mask, other image cues such as edge or colour could be used to reduce some ambiguities but at an increase in computation cost. Non-human objects (e.g. cars) should be added to the model set for more versatility but this too will increase computation and possibly result in more misclassify cations. Finally, the work should be extended to include tracking: tracking information will provide important temporal priors which will both resolve some ambiguities.

The study of Anthony C. et.al [13], on understanding crowd behaviour in semi-confined spaces is a crucial aspect of designing pedestrian facilities, making significant layout modifications to existing areas, and efficiently managing sites prone to heavy crowd traffic. Traditional manual measurement techniques fall short in providing comprehensive data on patterns of site occupation and movement. Real-time monitoring, while essential for safety, can be labour-intensive and exhausting. This paper introduces a set of image processing techniques currently under development at King's College London. These techniques leverage existing closed-circuit television (CCTV) systems to facilitate both data collection and real-time monitoring of crowds. The application of these innovative methods holds the potential to enhance our comprehension of crowd behaviour, inform better designs for the built environment, and ultimately bolster pedestrian safety.

Min Li, et.al [14], conducted a qualitative research study that introduces an innovative approach to tackle the challenge of estimating the number of individuals in surveillance scenarios characterized by gatherings and waiting. It includes method combines two key components: a MID (Mosaic Image Difference)-based foreground segmentation algorithm and a HOG (Histograms of Oriented Gradients)-based head-shoulder detection algorithm. Together, these components provide a highly accurate estimation of the count of people within the observed area. In researcher's framework, the MID-based foreground segmentation module identifies active regions, which are subsequently processed by the head-shoulder detection module to detect heads and calculate the precise number of individuals present. Authors have conducted a series of extensive experiments, and the compelling results unequivocally demonstrate the effectiveness of our innovative method.

The research conducted by Xiaoli Hao, et.al [15], delves into the development of an automated method for detecting and tallying vehicle occupants, particularly focusing on a novel face detection algorithm designed to accomplish this task. The methodology combines various techniques for precise occupant counting. Initiate the employ a lighting compensation skin tone model as an initial coarse detection method. This model aids in identifying skin regions within the vehicle's interior. Subsequently, we utilize the correlation of human skin colours as a more refined detection technique, enhancing the accuracy of identifying occupants. Mathematical morphological operations further refine the detection process, effectively pinpointing skin regions and generating potential face candidates. Finally, we implement a Fuzzy ART classifier to execute the critical function of occupant detection and counting. Experimental results affirm the algorithm's effectiveness, even under typical daytime conditions where challenges such as weak facial luminance and strong light reflections on the front window can be encountered. This research paves the way for robust and accurate vehicle occupant detection, contributing to improved safety and surveillance in various scenarios.

3. ANALYSIS

Table 3.1 presents a detailed analysis of previous studies with a tabular view of the summary, benefits, and TechStack mentioned in each article

Title	**Summary**	**Advantages**	**TechStack**
Smart Library Seat, Occupant and Occupancy Information System, using Pressure and RFID Sensors [1]	This paper addressed the issue of how library users/staff can remotely monitor seat occupancy status and occupant seat location in the library.	The system was found to be highly portable, easy to deploy and effective.	RFID reader and FSR. The Wi-Fi module (node MCU) is an IOT gateway that communicates with the database responsible for the storage of sensor results from the prototype.
Detection and Classification of Passenger Seat Occupancy using stereovision [2]	This paper describes the application of a pixel-based stereo vision method, for applications inside a car; the aim is to improve the passenger safety thanks to an active control of the airbag device.	These sensors will be able to provide information's to decisional modules which can process the raw data into an interpretable analysis of the observed scene.	ZNCC and CT algorithm with CCD cameras.

Seat Occupancy Detection Based on Capacitive Sensing [3]	In this paper, a straightforward yet effective scheme for detecting seat occupancy using the capacitive sensing principle. The identification of parameters such as the occupant's presence, position, and type on the seat is crucial for ensuring effective airbag control in vehicles.	Precise measurement of capacitance even in the presence of external electromagnetic interferences.	Utilizes capacitive sensing principles for detecting changes in capacitance between transmitter and receiver electrodes. A climax Board with a digital signal processor (DSP) is employed.
Crowd Density Estimation Using Texture Analysis and Learning [4]	This paper presents an automated method to detect abnormal crowd density in public places through texture analysis and learning. It utilizes a perspective projection model to generate multi-resolution image cells, enhancing density estimation in crowded scenes.	Automated Crowd Density Detection. The system automates the process of detecting abnormal crowd density, reducing the need for manual monitoring in public places.	Support Vector Machine (SVM) and Harris-Laplacian Space. The Gray level dependent matrix (GLDM) method proposed by Hara lick [3] is a classical statistical method for texture feature extraction.
A Machine Learning Approach to Vehicle Occupancy Detection [5]	This paper addresses the challenge of enforcing vehicle occupancy rules in managed lanes on highways efficiently. Traditional methods, such as visual inspections by traffic law enforcement officers, are costly, risky, and ineffective. Here an image-based machine learning approach is used for automatic or semi-automatic vehicle occupancy detection.	Machine learning techniques can be trained on large datasets, potentially leading to more accurate and consistent results in identifying violators.	DPM model, NIR is the most promising roadside detection technology with the ability to address many technical challenges for occupancy detection.
Research on a library seat management system. [6]	The system integrates information reading, lock/unlock, and data transmission for collecting and sharing seat occupancy data. Real-time seat management for administrators is enabled by consolidating and transmitting the information to the upper computer.	The system offers real-time seat occupancy data, enhancing the efficient allocation of library seats. And The system demonstrates stable performance, ensuring consistent and reliable management of seat occupancy within the library.	Arduino, RFID-RC522, Infrared Sensor, ESP8266. LabVIEW is adopted as the upper computer to analyse data in real time and create a display interface.
Automatic Water level monitoring and Seat availability details in train using Wireless Sensor Network.[7]	System for monitoring seat occupancy railway vehicles, aiding passenger decision-making. Utilizing IR sensors and wireless mesh sensor network, real-time seat availability and water level data are provided for	Passengers can make informed choices by knowing seat availability, improving travel satisfaction.	IR Sensors (Infrared Sensors. Float Water Level Sensor. Wireless Mesh Sensor Network. UART (Universal Asynchronous Receiver Transmitter)

	improved customer support and travel choices.		
Comparison of Face Detection and Image Classification for Detecting Front Seat Passengers in Vehicles. [8]	This paper proposes automated vehicle occupancy detection using NIR cameras for efficient enforcement in HOV/HOT lanes. Comparative study Favors image classification (BOW and FV) for accurate front seat occupancy detection.	Automation reduces costs associated with manual enforcement while potentially enhancing safety by minimizing the need for manual interventions on roadways. And Accurate Occupancy Determination	Near Infrared (NIR) Camera System Deformable Part Model (DPM). Image Classification using Bag-of-Visual-Words (BOW) and Fisher Vectors
People counting based on head detection and reidentification in overlapping cameras system. [9]	This paper presents a method for accurately counting people in overlapping areas of multi-camera surveillance systems. It employs a head detection approach using Siamese networks for re-identification, aiming to identify recurring individuals and improve population statistics accuracy. The proposed method calculates the median of total people across frames for more reliable results.	The proposed method outperforms SIFT-stitching in terms of recall, emphasizing its effectiveness in overcoming challenges posed by occlusion and poor picture quality	Capacitive Sensing and Carrier Frequency Method it also has Lock-in Amplifier Technique
People in seats counting via seat detection for meeting surveillance. [10]	This proposes a robust people-in-seats counting method utilizing a coarse-to-fine framework. It employs global and local features, overcoming challenges of varied appearances and occlusions, achieving a high accuracy of 99.88% on a real meeting dataset.	Robust Pattern Recognition: The coarse-to-fine framework effectively handles diverse appearances and outliers, ensuring accurate seat counting in challenging conditions.	Background Subtraction with SW-HOG (Shape-Weighted Histogram of Oriented Gradients). LBP (Local Binary Patterns)
Person Counting Using Stereo [11]	The paper presents a new method for shopper counting in stores, replacing traditional infrared beams with computer vision using a stereo camera above the entrance. Unique features include remapping stereo disparities into an "occupancy map" and tracking people using a Gaussian mixture model. The system achieved an impressive net counting error rate of just 1.4% with 900 events over 4 hours of video.	Real-Time Tracking. The system's low counting error rate of 1.4% demonstrates its reliability in accurately estimating shopper volume.	Gaussian Mixture Model Computer vision techniques. The system runs at 20-25Hz on 400Hz Pentium II.

Bayesian Human Segmentation in Crowded Situations. [12]	The paper introduces an approach for segmenting individual humans in crowded scenes captured by static cameras. This problem is formulated as a Bayesian Maximum A Posteriori (MAP) estimation problem and is solved using an efficient Markov chain Monte Carlo approach.	The primary advantage is its ability to segment and identify individual humans in crowded scenes	Bayesian Maximum a Posteriori (MAP). Markov chain Monte Carlo (MCMC) is a tool to sample a probabilistic distribution.
Crowd monitoring using image processing [13]	The paper introduces image processing techniques developed at King's College London, utilizing existing closed-circuit television (CCTV) systems to collect data and monitor crowds in real time. These methods aim to enhance our understanding of crowd behaviour, improve urban design, and enhance pedestrian safety.	The understanding of crowd behaviour facilitated by these techniques can lead to improved design of pedestrian facilities and urban spaces Increased Pedestrian Safety	Horn's optical flow algorithm. Image Processing
Estimating the Number of People in Crowded Scenes by MID Based Foreground Segmentation and Head-shoulder Detection [14]	This paper proposes a method to estimate the number of people in crowded scenes. Detection module is introduced for detecting head-shoulder shapes from the detected foreground areas and count the number.	Accurate Crowd Counting. Not only counts the number of people in crowded scenes, but also locates the position of each individual.	The system uses MID as a feature for detecting small motions in crowded areas. Background modelling methods, such as Gaussian Mixture Model (GMM), are avoided in places with people gathering and waiting.
An Automatic Vehicle Occupant Counting Algorithm Based on Face Detection [15]	The paper introduces a face detection-based method for counting occupants in vehicles, offering accuracy, robust performance under varying conditions, automation, and non-intrusiveness as its key advantages.	Accurate Occupant Counting with non-intrusive making it reliable for existing surveillance systems.	Lighting Compensation Skin Tone Model. Fuzzy ART Classifier for pattern recognition tasks.

4. CONCLUSION

In conclusion, we can represent a significant step towards patient-centric and operationally efficient healthcare delivery in hospital waiting areas. To make a lasting impact on the healthcare landscape, ensuring that patients receive the quality care they deserve while healthcare facilities optimize their resources to ensure the ever-growing demands of our healthcare system. Furthermore, CCTV's scalability allows for future expansion and integration into larger healthcare systems, promising a broader impact on the healthcare sector. By addressing our objectives within the defined scope, we seek to bridge the current gap in hospital crowd management, elevating patient experiences and empowering healthcare providers with real-time insights for efficient resource allocation and operational decision-making. Proper measures must be in place to address privacy issues and comply with regulations and commitment to data privacy and security aligns with the stringent healthcare data regulations and best practices, providing assurance to patients and healthcare providers alike. The usability testing conducted will ensure that it is not only effective but also user-friendly in diverse hospital settings.

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