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A Comprehensive Human Presence Analytic Platform Using Computer Vision

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A B S T R A C T

The system consists of multiple cameras strategically placed in key areas, such as classrooms, workplaces, or event venues. The first step involves real-time people counting using computer vision algorithms. These algorithms detect and track individuals as they enter or leave the monitored area, ensuring accurate and efficient counting. Once the people counting is complete, the system utilizes advanced face recognition algorithms to identify individuals. Facial features are extracted and compared to a pre-existing database, allowing for precise identification. This information is then linked to the attendance record of the respective individual. The proposed system offers several advantages, including reduced administrative workload, improved accuracy, and enhanced security. It eliminates the need for manual attendance taking, minimizes the chances of proxy attendance, and provides real-time attendance data. Moreover, the system can be customized to generate automated reports for various purposes, such as payroll or academic assessment

Keywords: People Counting System, Computer Vision, Machine Learning, Crowd Management, Object Detection

INTRODUCTION

Human presence analytics platforms are becoming increasingly relevant in today's world. As the world becomes more urbanized and populated, there is a growing need to monitor and manage human activity in public spaces. Human presence analytics platforms can help to improve safety and security, optimize traffic flow, and enhance customer experiences.

a. Security
b. Crowd control
c. Retail analytics
d. Access control
e. People counting

The relevance of this project extends to any scenario where real-time monitoring of human presence and demographics can provide valuable insights, enhance security, or improve resource allocation. However, it's important to consider ethical and privacy implications and adhere to relevant laws and regulations when implementing such technology, especially when it involves facial recognition and gender identification.

In addition to these specific applications, the "Human Presence Analytic Platform" project could also be used for more general research and development purposes. For example, it could be used to study the behavior of people in crowds or to develop new methods of human-computer interaction. Overall, the "Human Presence Analytic Platform" project is a versatile and powerful tool that has the potential to be used in a variety of different ways. It is a project that is both relevant and timely, given the increasing importance of artificial intelligence and machine learning in our world.

In recent years, the rapid advancement of machine learning (ML) techniques and the availability of large datasets have paved the way for innovative applications in various fields. One such application is the "People Counting and Gender Recognition System" which combines image/video processing with ML to achieve accurate and automated people counting and gender classification.

A "People Counting System" is an innovative project to accurately detect and analyze human presence in images. The core components of this project involve training a machine learning model to understand human facial features and body characteristics. This system combines advanced computer vision techniques to achieve multiple objectives, such as recognizing human faces, identifying distinct body parts, determining gender, and effectively counting the number of individuals within an image or a video stream.

LITERATURE SURVEY :

[1]S. D. Khan, Y. Salih, B. Zafar, and A. Noorwali, 2021.This project focuses on automated crowd analysis, a critical aspect of efficient crowd management, with applications such as panic detection, crowd behavior understanding, tracking, congestion detection, and crowd counting. Crowd counting, in particular, has garnered significant attention due to its potential applications in crowd surveillance and scene understanding, essential for managing massive gatherings like the Hajj and Umrah.

[2]H. Zhang, H. Chang, B. Ma, S. Shan, and X. Chen ,2019.Object detection is a critical field in computer vision with two main categories: one-stage and two-stage detection. Recent research aims to enhance detection performance. Cascade methods have been introduced to improve localization and confidence scores. However, current cascade single-stage approaches suffer from feature inconsistency and classification-confidence mismatch. This paper presents Cas-RetinaNet, a cascade single-stage detector that addresses these issues. It gradually raises IoU thresholds for improved classification confidence and introduces a Feature Consistency Module (FCM) to maintain feature consistency. Cas-RetinaNet outperforms state-of-the-art detectors, achieving stable performance gains.

[3]B. Saleh, K. Sultan Daud, and U. Habib, 2019.This project addresses the challenges posed by growing crowd occurrences at events and gatherings due to population increase and urbanization. It focuses on crowd analysis, especially crowd counting and localization, to enhance public safety and event planning. The project introduces a novel approach for generating scale-aware object proposals and a classification network to distinguish between heads and background, improving crowd counting accuracy in diverse crowd scenes, including high-density situations.

[4]Z. Li, C. Peng, G. Yu, X. Zhang, Y. Deng, and J. Sun,2018.Furthermore, there's been a focus on accounting for input-dependent noise variances and correlations, non-stationary covariance function amplitudes and length-scales, and heavy-tailed predictive distributions in Gaussian process regression. In this paper, a new framework, Gaussian Process Regression Networks (GPRN), is introduced. GPRN combines the structural properties of Bayesian neural networks with the nonparametric flexibility of Gaussian processes.

[5]Y. Li, X. Zhang, and D.Chen,2018.This project focuses on developing advanced network models for crowd analysis, particularly in the context of crowd flows monitoring, assembly control, and security services. The progression in crowd analysis has evolved from simple crowd counting to generating density maps, as merely counting people is insufficient for understanding the complex crowd distributions, which can vary significantly even with the same number of individuals.

[6]D. Sam Babu, S. Surya, and R. Venkatesh Babu,2017.This project addresses crowd counting for geo-political and civic applications, such as protests and gatherings. It introduces Switch-CNN, a novel CNN architecture for crowd density prediction, leveraging scene variations to enhance accuracy. Switch-CNN outperforms traditional methods and achieves state-of-the-art results on major crowd counting datasets.

[7]Y. Zhang, D. Zhou, S. Chen, S. Gao, and Y. Ma,2016.Crowd analysis, particularly accurate crowd counting, has gained significant importance in recent years due to tragic incidents like the 2015 Shanghai stampede and subsequent events worldwide. Computer vision technology plays a vital role in crowd control and public safety. Precise crowd estimates are essential for event planning, space design, and can be applied to diverse domains like cell counting, wildlife monitoring, and vehicle counting.

[8]A. G. Wilson, D. A. Knowles, and Z. Ghahramani,2011.Gaussian process models have gained popularity for solving non-linear regression and classification problems, offering expressiveness, interpretability, and avoiding overfitting. These models, originally stemming from neural network research, provide impressive predictive performance. There has been an increased interest in extending Gaussian process regression to handle correlations between output variables (multi-task learning). This enables better predictions, especially when dealing with related measurements, such as heavy metal concentrations in geographical areas.

NEEDS

The project on people counting using computer vision addresses critical needs across diverse sectors. Businesses, particularly in the retail industry, require accurate and real-time information on customer foot traffic to optimize store layouts and enhance customer experiences. Public spaces and transportation hubs have a pressing need for efficient people counting systems to ensure public safety, manage crowd flow, and optimize security measures. The project fulfills the need for robust solutions that go beyond mere counting, incorporating innovative features such as adaptive learning, privacy-preserving techniques, and multimodal fusion, making it versatile and applicable in various settings. By meeting these needs, the project not only contributes to operational efficiency but also aids in informed decision-making, resource allocation, and the overall improvement of safety and user experiences in public spaces and commercial establishments.

1 Operational Efficiency in Retail:

Retail businesses require accurate people counting to optimize store layouts and allocate staff efficiently, enhancing operational efficiency and improving the overall customer shopping experience

2 Public Safety in Crowded Spaces:

In crowded public spaces like airports or stadiums, there is a need for effective people counting systems to ensure public safety, manage crowd flow, and optimize security measures, preventing overcrowding and potential security risks.

3 Adaptive Systems for Dynamic Environments:

Businesses and public spaces operating in diverse environments require people counting systems with adaptive learning capabilities, allowing the model to adjust to changing conditions, ensuring accurate counting across various settings and lighting conditions.

SCOPE

The scope of this project is to develop a robust and adaptive people counting system using computer vision and machine learning. The system will provide accurate real- time counting of individuals in diverse environments, catering to the needs of retail businesses, public spaces, and transportation hubs. The project aims to go beyond conventional counting methods by integrating innovative features such as privacy-preserving techniques, multimodal fusion, and adaptive learning models. The envisioned system will not only optimize operational efficiency for businesses but also contribute to public safety and resource management in crowded spaces, addressing the evolving challenges faced by various sectors. Ultimately, the scope is to deliver a versatile solution that enhances decision- making processes, improves user experiences, and meets the demand for accurate, privacy- conscious people counting across different domains.

RESEARCH METHODOLOGY

The research methodology involves a comprehensive approach, starting with an in-depth literature review to understand existing methodologies and identify gaps. The project will then proceed with data collection, utilizing diverse datasets to train and test the machine learning model for people counting. The development of a highly accurate algorithm will be a key focus, incorporating computer vision techniques and ethical considerations for privacy. The system's performance will be rigorously evaluated using appropriate metrics, and iterative refinement will be applied to enhance accuracy, robustness, and scalability. The research methodology will be an amalgamation of theoretical exploration, practical implementation, and continuous feedback loops to ensure the development of a reliable and effective people counting system.

- Problem definition: This step involves clearly defining the problem that the project is trying to solve. For example, the project may be trying to count the number of people in a given image or video, identify the gender of people in a given image or video.
- Literature review: This step involves reviewing the existing research on the problem
- Data collection: This step involves collecting the data that will be used to train and evaluate the machine learning model.
- Feature extraction: This step involves extracting features from the data that are relevant to the problem.
- Model training: This step involves training a machine learning model on the data that has been collected and pre-processed. The model can be trained using a variety of machine learning algorithms, such as support vector machines, decision trees, and deep learning models.
- Model evaluation: This step involves evaluating the performance of the machine learning model on a held-out test dataset. This will help to determine how well the model will perform on new data.
- Deployment: This step involves deploying the machine learning model on a real-world application. This can be done using a variety of hardware and software platforms.

System Architecture

This web application is tool for cable operators or service providers, automated software for bill collectors, and a billing and service

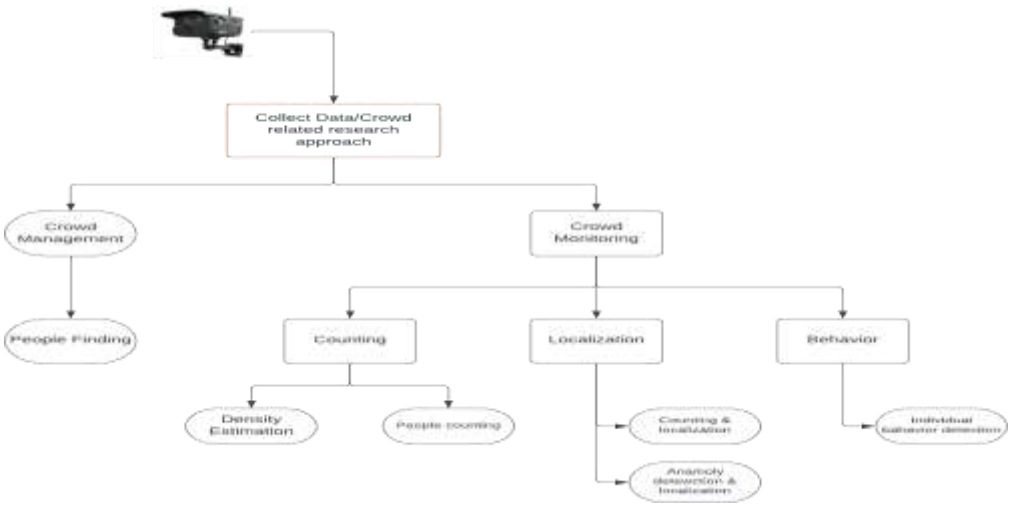

Fig 4.1: Architecture Diagram

Detail Working

We have discussed two aspects of crowd monitoring in this report. The most notable point is the exceptional research on vision based crowd monitoring techniques. In order to address the privacy laws, focus needs the shifted to less-intrusive and privacy preserving crowd monitoring techniques. Both, vision and non-vision techniques can compromise the privacy of an individual, either by facial recognition. While security oriented technologies might have permissions to identify and track individuals, general crowd monitoring techniques need to focus more on intrusion and privacy. Crowd monitoring is an important research area and in order to develop effective technologies, it is necessary to test the newly proposed techniques in different crowd scenarios.

Our model is directly taken from the real time monitoring cameras installed in public areas where the model will be installed in the system and the camera video is taken as input, rectangles are used to highlight the crowd violations where green rectangle insist no violations whereas red rectangle insist that there is a crowd violation in a particular area, the crowded area is identified with the help of pixel positions of the people in the video

CONVOLUTION NEURAL NETWORKS (CNN):

Deep Convolutional Neural Networks achieved remarkable success various fields of computer vision such detection, classification, and semantic segmentation. Some researchers made proposed different deep learning frameworks f crowd counting in the recent two years. For crowd counting, Wang et al. [15] proposed first regression base CNN model. Fu et al. [16], on the other hand, proposed a deep convolutional network that classifies the input image into five classes. Shang et al. [17] leverage contextual information at both local and global levels estimate the crowd count by employing end-to-end CNN. Zhang et al. [18] proposed architecture that consists of multiple , where each column implements a CNN each having different receptive fields to capture scale variations caused by perspective distortions. Onoro-Rubio et al. [19] proposed a scale-aware crowd density estimation model, Hydra CNN that estimates crowd densities in complex crowded scenes without the need of geometric information of the scene. Sang et al. [20] propose a method, namely, saCNN that estimates high-quality density maps, where crowd count is obtained by the integrating these density maps. Sindagi et al. [21] proposed end-to-end cascaded CNN that simultaneously estimate the crowd count and density maps. Liu et al. [22] proposed DecideNet that separately generates different density maps. Zhang et al. [18] estimated the number of people in a single image using a Convolutional Neural Networks (CNNs) regression model with two configurations

CONCLUSION

In conclusion, a Human Presence Analytic Platform powered by Computer Vision offers a robust solution for real-time monitoring and analysis of human activities in various environments. This technology has the potential to revolutionize industries such as retail, healthcare, and transportation, providing valuable insights and automating tasks. With continued advancements in computer vision and machine learning, this platform is poised to play a pivotal role in the future of smart and safe spaces.

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