Study on Crowd Density Estimation and Location Prediction in Public Transport System

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Abstract **- Existing and Emerging technologies help to solve real-time problems without manual interference. Crowd analysis and location prediction in transport systems is an essential topic for research. It not only helps in transport system management but also in urban planning, public safety, and environment management. These Intelligent systems provide a vital role in extracting the location of transport and calculating the number of passengers, with the shortest path of travel. This survey paper covers different approaches for crowd density estimation such as deep learning, IoT, algorithms, image, and video- based and for location prediction using GPS tracking, smartphone technology, and so on. Therefore, an appropriate method has to be chosen to get maximum accuracy with solutions for all the existing problems with few enhancements.**

Index Terms **- Crowd Density, IOT, Location Tracking, Prediction, GPS.**

I.INTRODUCTION

Public transport plays a very important role so as to optimize the traveler's comfort and traffic congestion. In cities, buses are typically the well-liked walk travel, because of their low-cost rates and intensive routes. The development of the general public transportation system is critical to society's ability to perform reliably. Public transportation systems will make better use of their time in order to provide better service to society. If real-time data like the crowds in buses are frequently gathered for intelligent transportation systems, it will not only make it easier for transport agencies to provide services, but it will also make it easier for travelers to utilize their journey times. For expanding urban growth, urban quality, urban safety, and operations, the ability to sense and predict population movements in cities is essential.

Stability analysis of crowds is a major research area in the field of disaster management due to the low cost of cameras and transmission bandwidth. Crowd density is the simplest and efficient basis for crowd stability study. The lack of a credible and appropriate transportation information system, primarily to riders or commuters who take public transportation, notable buses for commuting, brings a deep concern, specifically buses for commuting causes a lot of anxiety among them. The use of public transport services may be improved if real-time vehicle information, such as seating availability, current location, and travel time, were made more easily accessible. As a result, a smart information system based on IoT has been proposed to provide passengers with advance notice of the bus's current location, duration, and crowd density within the bus.

II. LITERATURE REVIEW

It was recently reported on a few recent work on real-time crowd density monitoring and location tracking in public transportation. The report contents are evaluated with their pros and cons.

Traveling in public transport is common during this generation, applicable in that it is necessary to empower travelers in order to optimize their journeys in terms of travel time.

In addition to this, the authors gave information on the number of passengers inside the public transport to provide comfort. These should be self-addressed with viable approaches. The concept is that WLAN-enabled mobile devices transmit so-called probe queries as protocol operations on a constant schedule to discover nearby access points. By network monitoring Hardware, can monitor the presence and absence of

probe requests from which count of mobile devices are done through which passengers can be determined. Also by the use of GPS models, we can determine the duration as well as the path of the vehicle from source to destination. This results in systems that include features like sufficient accuracy, full automation, low cost, low latency, low privacy impact. The initial results indicate that the system will offer an affordable estimate while not requiring any manual intervention [1].An in-depth look at a variety of data sources used in various urban applications, as well as the region is to highlight the benefits and possibilities of urban data production systems and supporting processing technologies. Then, using data from all accessible associated with technology sources, a functional crowd event detection system is implemented. Finally, various outstanding difficulties and intriguing research avenues are presented, along with existing open-access crowd information for detecting urban incidents and relevant Application Programming Interfaces [2].For wide-area surveillance applications, a video-based system for prediction and analysis is other option. To rectify distortion a geometry module is used with AMID-based technique in congested regions. The liner fitting approach is used to estimate the number of persons in a crowd, while the optical flow method is used to estimate the velocity. The module for prediction is used. Determines crowds at a particular location using a prediction module. [3]. The work was broken into three sections and used video surveillance dynamic information analysis to estimate the population density in a tourist destination. A new scale perception module and an inverse scale perception module have been developed to improve the counting model's mining of multiscale information. It generates density map, with void rates and branch regressions [4]. Advanced image processing technology improves crowd counting accuracy by expanding the number of columns in a standard convolutional neural network (CNN) and obtaining high-precision crowd density data through image correction. Then, using the well-known support vector regression (SVR) algorithm, it investigates pedestrian kinematics and suggests a novel crowd density prediction model. The prediction of crowd density changes in public locations can be performed by anticipating the position of groups of pedestrians in the next few moments, which gives data support for crowd stability studies [5]. The intelligent public transportation system is created by an internet-enabled gadget with the public transportation system. This study presented an intelligent public transportation system that uses the Internet of Things to provide a precise estimate of the arrival time of the transport at specified bus stations [6]. A revolutionary method of calculating crowd density has been proposed. To infer the placements of objects in congested situations, to estimate velocities, an intense optical flow with temporal and spatial filtering is being used. The elements are grouped using a hierarchical clustering algorithm based on the Euclidean distance metric. Our preprocessing and localization of object movements, without temporal post-processing, result in hierarchical clusters that are highly disciplined and accurate, as shown by the clusters' Cophenetic correlation coefficient. [7].The column-structured deep neural network (COL-DNN-R) is a deep neural network approach for estimating population density in an interior space based on previous Wi-Fi traces of individual visitors. For feature extraction, COL-DNN receives raw information such as population density, opening and closing hours, and peak visitor counts, and provides a framework designed to minimize feature extraction. A regression model R is used to forecast crowd density using the retrieved features [8]. Artificial intelligence technology is crucial in fostering or even enforcing the practice of social separation. It can produce precise people counting models from any single image, irrespective of crowd density or camera angle. DCNN, a new deep CNN, had been suggested. The suggested model relies on the small convex size structure of the VGG-19 and can handle any photo resolution. It results in lower MAE when employed state-of-the-art techniques [9]. The method includes two deep learning models one is the convolutional auto encoder to extract the crowd features to indicate number of passengers next is the YOLOv3 architecture for detecting the features of the head count clearer. The findings are combined together to determine the bus's present passenger occupancy rate. Experiments were carried out to calculate the number of passengers at various bus schedules and bus stops in order to demonstrate algorithmic performance. [10].The population is gradually increasing in major metro cities due to issues like traffic congestion and public transport not arriving in time. To avoid these the IoT sensors and cloud storage are used to store the data from the vehicles.

Two infrared sensors that also can detect an object (person) within its range would be connected to a NodeMCU module to track passenger inbound and outbound movement and update the cloud count as a result. The (Global Positioning System) GPS system is fitted to determine the estimated time of arrival of the vehicles and, as a consequence, to communicate the arrival time. This solution makes the passengers to plan and make better decisions for the travel in public transport [11].The suggested system is an IoT- based remote monitoring system that involves a smartphone app that provides real-time information regarding bus position as well as seat availability within buses. The GPS module is used to detect the bus's location, and the IR sensors connected to the Raspberry Pi are used to assess seat availability [12].Methods for assessing crowd density have gotten

a lot of attention and have been used in a variety of scenarios. Counting people at a festival, managing crowds, and supervising pedestrians are just a few examples. For example, estimating customer counts in retail outlets and subway management. Using a single Wi-Fi router and a receiver with an off-the-shelf 802.11n Intel 5300 NIC, a CSI-based crowd density estimate framework for the interior environment is constructed. The incoming data are compiled and CSI amplitude measurements are used in this method [13]. The suggested concept attempted to reduce energy usage by forecasting bus station capacity, autonomously tracking air - conditioning system and lighting, immediately reporting power faults, and assessing quality of the air in the surrounding area .Bus stops will be supplied with a Wireless Internet-based solitary microcontroller that will be coupled to sensors and devices in order to do this. The microcontroller provides sensor readings to a real-time cloud database and includes a smartphone website that warns operators or maintenance personnel when abnormal readings or problems occur. The smartphone app has a mapping interface that enables controllers to monitor the state of bus stations from far. [14]. One of most efficient and cost-effective alternative for transporting individuals and groups from one area to another is to use public transportation (PTS). The public transportation infrastructure that connects the Gidan-Kwano and Bosso campuses were utilised to develop and test a geographical map-based automotive surveillance system. [15].

III. LITERATURE SUMMARY

The summary of the literature is depicted in table 1.

Table 1: Summary of Literature Survey

Sl No	Author Names	Year of Publication	Methodology	Pros	Cons
[1]	Marcus Handte et.al	2014	Using Wireless internet, smartphones make probe responses on a regular basis as a protocol operation to locate nearby access sites. GPS is used to discover routes, find the quickest pathways, and compute exact positions.	Reduce overall bandwidth utilization while safeguarding passengers' privacy	Application must achieve balance in the loading on the overall public transportation system, which would improve traveler comfort as well as reduce operating costs of the network.
[2]	M Shamim Kaiser et.al	2017	For various urban applications, a survey was conducted using multiple data sources.	Open-access crowd datasets for detecting urban incidents, and also relevant Application Programming Interfaces, are provided	Issues such as uncertainty in noisy data, data verification and integrity, and fusion and fusion rule have not been addressed
[3]	CAO Lijun et.al	2013	For crowd extraction, it uses monocular image sequences as well as the cumulative Mosaic Image Difference algorithm. Foreground-based methods	The algorithm provides well with both low and large crowd density circumstances.	The parameter has to be chosen based on the scenario adoption.

			include LK optical flow & GEM methods or directed Structural diagrams for system framework for wide-area surveillance. Feature-based methods which include Hear & integral channel feature-based head detection and SVM (support vector machine) solve regression problems. Texture-based approaches, for example, extract crowd information such as crowd speed, direction, and position.		
[4]	Lina Li et.al	2020	Deep learning and convolutional neural networks(CNN) based algorithms to detect crowd density	In this work, an additional count classifier was added into the count system to manage the extra job of count categorization and to improve the model's capacity to absorb information content, as driven by multitasking learning.	Data security.
[5]	Rongyong Zhao et.al	2020	Crowd density based on CNN and image correction. Crowd density based on SVR.	It generates reasonably accurate statistics on crowd density.	CNN and SVR complexity is very high and consumes more time to gather accurate information.
[6]	Jalaney Jabamony et.al	2019	This proposed method uses artificial neural networks (ANNs) for setting the waiting time prediction. Many nonlinear and linear parameters are considered for executing the prediction procedure.	It can improve the system's accuracy using the provided methods.	In addition to incorporating several variables that are affected by chance, predicting a bus's arrival time can be very difficult.
[7]	Aravinda S. Rao et.al	2017	A block-based dense image enhancement filtering by temporal and spatial properties can also be used to deduce an object's location. The objects are then clustered using hierarchical clustering. For a specific view, a model incorporated into the scene is created. Optical flow is divided into two types: Horn-Schunck and Lucas-Kanade.	Due to fluctuating Environmental conditions and opacity, surveillance systems have difficulty identifying motion in the scene. This method is used to solve the problem.	All methodologies must be carried out correctly, and density estimation requires training. Time is consumed, and the level of difficulty rises.
[8]	Akihito SUDO et.al	2017	COL-DNN features are used to extract prediction accuracy, and MLP is being used as the regression model.	In order to accomplish this, Over time, it collects wireless networks traces of visitor positions in order to not be limited by layout or video quality.	COL-DNN-R may be improved with densities at multiple levels, more look-ahead options, and a configurable interior setting by employing more complex machine learning approach including such auto-encoders, recurrent neural networks, even constrained Boltzmann machines.
[9]	Salma Kammoun Jarraya et.al	2021	Crowd counting approaches include the detection-based technique, the regression-based method, the density estimation-based framework, as well as the CNN-based approach. The scale-sensitive model uses a sophisticated and robust CNN model in various dimensions, such as the multi-column architecture. Context Pyramid Model (CPCNN) To improve the quality of mass density prediction, the approach explicitly incorporates local and global situational data from large amounts of photos. With a larger array of column -	It generates accurate people-counting models from any image, regardless of crowd density or camera viewing angle.	As the complexity of the CNN increases, the model suffers from ineffective branching structures and long training times.

			oriented structures, the CSNet model increased the density map's quality.		
[10]	Ya-Wen Hsu et.al	2020	The number of passengers in the image is determined using a deep learning object detection technique. This technique uses CAE architecture with the deep learning object detection algorithm.	The findings show that the suggested system outperforms several existing approaches.	Regardless of the fact That perhaps the methods utilized in this study increased projected performance, the suggested CAE based method network model still is susceptible to visible light, which has an impact on accuracy.
[11]	Paras Kadam et.al	2020	Using NodeMCU and IR sensors for the data and cloud application to store the same. Data can be found out by the passenger counting algorithm for the sensors.	Easy to use and less expensive to implement.	This needs an android application but in India, android mobiles are still not fully functional
[12]	J John Paul et.al	2021	Automated passenger counting system using the IR sensors. For the location, a GPS module is used.	The advantage is that the information is precise, accurate, and practically implementable as it is cost-effective.	The GPS location may take some time as it should be constantly changing all the time.
[13]	Chii Chang et.al.	2018	The system's three major phases are study, information processing, and segmentation. Researchers developed, tested, and verified a device-free indoor crowd density method for detecting CSI information from a data Wireless receiver. Researchers analyzed the nature of each transmitted stream's CSI amplitude distribution throughout distinct subcarriers and proposed a method for collecting the CSI amplitude across time without wasting crucial information.	Using the weighted K-nearest neighbor method, the presented approach achieves an estimation accuracy of 99.8%.	Does not forecast the precise amount of individuals in multiple locations
[14]	Miraal Kamal et.al	2019	The bus station is provided with a separate Wireless internet microprocessor, as well as sensors and actuators. The microcontroller includes a smartphone application which feeds sensor information to an internet real-time database to alert operators or maintenance professionals of unusual readings or malfunctions.	The prototype conserves energy by monitoring the bus station depending on occupancy. The system can control lighting and air conditioning by continuously tracking the occupancy of the bus stop.	Bus stop status was not monitored at any of the existing factories in terms of occupants, air conditioning, lighting and environmental pollution.
[15]	Onemayin David jimoh et.al	2020	To construct a sophisticated public vehicle monitoring program for commuters on major metropolitan roadways that employs GPS to find and monitor geographic maps, a mix of hardware devices and software development encoding is necessary. Each vehicle was equipped with a vehicle tracking device and Google Maps monitoring software is used to track the vehicle's location, capture data and information, and transmits the information to something like a graphical system. At the observation station, a Raspberry Pi ARM Cortex A53 CPU with a universal transmitter has already been installed to facilitate interaction between both the base station and the remote location. They utilized the Arduino Integrated Development Environment (AIDE) to design the Atmega328P, which serves as	The Global positioning system (gps) selection approach's minimal inversion matrix GDoP technique is very effective and gives impressive experience in gauging precision and accuracy.	No traffic analysis (noise) of major urban arteries, no bus shuttle timetable informations

			the vehicle monitoring device's core controller.		

IV. METHODOLOGY

The density of crowds as assessed by deep ConvNets extract features directly and map them to different crowd density levels, such as very little, moderate, heavy, and extremely high. The number of persons in each range, as well as the total number of ranges, may vary depending on the application and local conditions. The below Fig.Ⅱ shows the proposed methodology.

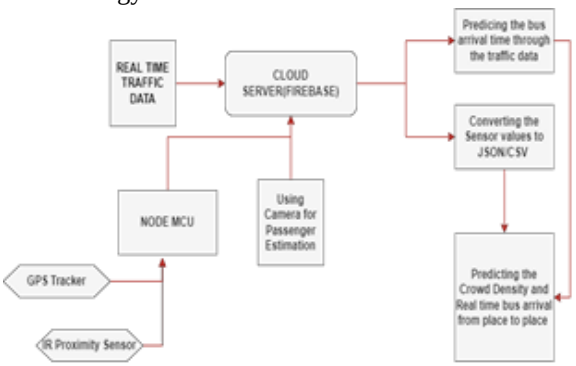

Figure 1: Methodology

Considering all the other literature, we have come up with our methodology. This includes the combination of IoT and Deep Learning for crowd density, crowd counting estimation. Deep learning techniques include convolutional neural network(CNN), Backpropagation, Gradient descent, and so on. CNN plays a major role in better accuracy and flexibility in crowd density estimation. Global Positing system for the location prediction and all the data which is stored in the cloud database will be given as an input to other prediction models for more accurate information to the general public. From the proposed methodology we can conclude that, as public transport is essential in everyday life efficient use of them by the public is important so with the addition of different technologies there can be a better transport system.
The implementation of proposed methodologies will be considered in the future.

V. CONCLUSION

Emerging technology has been incorporated in our daily lives. Using this technology to increase the standard of living has become a great challenge. Current urban public transportation systems encourage users to utilize time effectively. This can be a viable approach for existing systems. Relevance to social aspects as Intelligent transportation systems will help the public in commuting by the use of Computers, Algorithms, Electrical equipment, Sensors, etc. In this paper, a variety of crowd density techniques and the relative benefits, capabilities, and the use of diverse data gathering and processing technologies enabling crowd density monitoring is highlighted in public transit location prediction.

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