DETECTING SOCIAL DISTANCING USING DEEP LEARNING AND ARTIFICIAL INTELLIGENCE

Nandhini N [1], Pooja V [2], Akshara P [3], Swathy Priyadharsini P [4]
[1, 2,3] UG – B.E Computer Science and Engineering, Bannari Amman Institute of Technology,
[4] Assistant Professor, Computer Science and Engineering, Bannari Amman Institute of Technology, Sathyamangalam, Tamil Nadu.

nandhini.cs20@bitsathy.ac.in, pooja.cs20@bitsathy.ac.in, akshara.cs20@bitsathy.ac.in, swathypriyadharsini@bitsathy.ac.in

ABSTRACT

In recent years, the world has witnessed unprecedented challenges brought about by the outbreak of infectious diseases, such as COVID-19, that require rapidand effective responses to ensure public health and safety. Social distancing has emerged as a crucial measure to mitigate the spread of contagious diseases in crowded settings. However, monitoring and enforcing social distancing in crowdedspaces can be a complex and resource-intensive task. This project presents a novelapproach to address this challenge by harnessing the power of big data analytics, deep learning, and artificial intelligence (AI). We propose a system for crowd surveillance that leverages advanced computer vision techniques to monitor socialdistancing compliance in real-time. The key components of our system include datacollection, pre-processing, deep learning-based object detection, and intelligent decision-making. The data collection process involves the deployment of high-resolution cameras and sensors in public areas and other crowded spaces. These devices continuously capture video and sensor data, creating a massive influx of information. Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) are used to analyze visual data, identify individuals, and track their movements. Our big data-enabled crowd surveillance system provides real-time insights into social distancing compliance, allowing for rapid intervention when violations occur. By leveraging the power of big data and AI, our system can enhance public health and safety efforts in crowded environments,contributing to the containment of infectious diseases. This project outlines a cutting-edge approach to crowd surveillance for social distancing using big data analytics, deep learning, and artificial intelligence.

Keywords: Acronyms: YOLO-You Only Look Once, COCO-Common Objects in Context,DNN-Deep Neural Network.

1. Introduction

During the COVID-19 pandemic in many countries, maintaining a mask is mandatory and indeed, it reduces the fatality rates. As long as the vaccine is not widely utilized and is not fully protective for every person, maintaining a social distance is crucial. It is essential to prevent the spread of infection. The authorities need a way to monitor public places like subway stations and shopping centers. Therefore, a need for social distance arises. Because face detection is a vital part of this process, it requires a large amount of time and resources if done manually and increases the chance of making mistakes in detecting social distance. Machine learning and computer vision techniques may help to automate this process. The coronavirus disease 2019 (COVID-19) epidemic has arisen as a major menace all around the world. As the number of cases is gradually increasing day by day, the government has several difficulties in controlling the pandemic situation. The communication of this disease can only be lessened with the proper collaboration ofpeople. We followed hand sanitizing, and social distance has proven to be quite efficient in controlling the spreading of the virus, but everyone is not obeying the guidelines. India would have trouble preventing the spread of the coronavirus.

Social distance is the most effective way to minimize transmission. When it comes to reducing disease transmission, this has shown good results. Varioustechnologies like machine learning (ML) algorithms artificial intelligence (AI)approaches, Internet of things (IoT), and unmanned aerial vehicles (UAV) give a real-time scenario at any given point about the number of people following physicaldistancing The faster R-CNN model is used for detecting faces and people’s activities.

In light of unprecedented global challenges brought about by the emergence of infectious diseases, it has become crucial to prioritize the implementation of effective public health measures to safeguard the well-being of societies. One of the primary tactics for controlling the transmission of contagious diseases like the COVID-19 pandemic is the practice of social distancing. However, monitoring and enforcing social distancing measures in densely populated areas and crowded spaces present significant difficulties for authorities and organizations. Traditional surveillance methods often prove inadequate in delivering real-time, precise, and scalable solutions for overseeing compliance with social distancing rules in large crowds. This is where the integration of big data, deep learning, and artificial intelligence (AI) emerges as a groundbreaking approach to address this critical issue.

This project introduces an innovative system for "Utilizing Big Data, Deep Learning, and Artificial Intelligence for Crowd Surveillance to Enforce Social Distancing." This system seeks to transform how we oversee and implement publichealth measures in crowded settings. The contemporary world is marked by an unprecedented proliferation of data sources, including high-resolution cameras andsensors, as well as the ubiquity of digital devices. Harnessing this wealth of data, our proposed system combines advanced computer vision techniques, deep learningmodels, and AI algorithms to create an intelligent and proactive crowd surveillancesolution. In doing so, it meets the urgent requirement to ensure effective adherenceto social distancing guidelines. This introduction lays the foundation for an in-depthexploration of our innovative approach. In the subsequent sections, we will delve into the intricacies of our system, encompassing data collection methods, preprocessing approaches for managing extensive data sets, deep learning-based object detection, and intelligent decision-making processes. Furthermore, we will discuss the benefits and potential applications of thissystem, with a focus on its ability to adapt to evolving circumstances and guidelines. In an era where public health and safety take precedence, our"Utilizing Big Data, Deep Learning, and Artificial Intelligence for CrowdSurveillance to Enforce Social Distancing" system presents a promising solutionto the challenges posed by managing crowds during outbreaks of contagious diseases. By amalgamating cutting-edge technology with the vast reservoir of available data, we aspire to contribute to the overarching goal of safeguarding communities and curtailing the spread of infectious diseases in densely populated environments.

2. Related Works and Literature Survey

Jaya Aravindh V. V,2021, proposed that three years later, another outbreakof the coronavirus disease occurred, and it has reemerged with various mutations, impacting the world profoundly. The consequences for humanity have been significant. Our primary defence against this pandemic is the mandatory use of facemasks and the practice of social distancing. However, manually inspecting compliance with these measures across a densely populated country like India is impractical due to the vast human resources required. To address this challenge, theCOVID-19 Social Distancing Detector System has been developed. This system is a single-stage detector that utilizes deep learning to incorporate advanced semanticdata into a Convolutional Neural Network (CNN) module. Its purpose is to both ensure the maintenance of social distancing and monitor violations within specific regions. By leveraging existing security footage, CCTV cameras, and computer vision (CV), it can also identify individuals not adhering to social distancing guidelines. While this technology provides a powerful tool for safety and security, it does not entirely replace human oversight, as manual monitoring isstill needed to track and report violations.

Sangeeta Yadav, et al.,2022, proposed that by using OpenCV and YOLOv3 techniques, social distance monitoring using machine learning automatesthe observation of social distance in public areas. It employs a trained deep learningmodel named YOLOV3 to find people in a camera's recorded video stream. The program then calculates the distances between each pair of individuals it has identified, flagging any that are close to a certain distance threshold as possibly breaking social distancing laws. With bounding boxes created around the detectedpeople and a label indicating whether they are in breach of social distance standardsor not, the program shows the output video stream in real-time. The technology continuously scans the video stream, looks for instances of social distanceviolations, and immediately gives visual feedback.

G., Salee m Durai, M.A, et al.,2019, proposed that this paper presents an extensive survey that begins with object recognition, proceeds to action recognition, delves into crowd analysis, and ultimately explores violence detection in crowded environments. Most of the reviewed papers in this survey rely on deep learning techniques. The survey systematically compares various deep learning methods in terms of their algorithms and models. Its primary focus is on the application of deep learning techniques to accurately identify the number of individuals involved and their activities in large crowds under diverse weather conditions. The paper also examines the underlying deep learning technologies employed in various crowd videoanalysis methods. Furthermore, it acknowledges the importance of real-time processing, an aspect that still requires more exploration in this field. Currently, there are few methods capable of addressing all these challenges concurrently. The paper identifies and summarizes the issues present in existing methods and outlines future directions to mitigate the identified obstacles.

Abdulaziz A. Alsulami, et al., 2013, proposed that surveillance cameras have recently found widespread use in delivering physical security services acrossa variety of private and public spaces on a global scale. The proliferation of camerashas been driven by the increasing demand for monitoring and recording unusual occurrences. The task of identifying anomalies can be challenging and time- consuming when relying on human observation, especially for specialized securitypurposes. Abnormal events represent deviations from typical patterns and are inherently infrequent. Moreover, collecting or generating data related to these rareevents and building models for abnormal data can be formidable tasks. Hence, thereis a pressing need to develop an intelligent approach to address this challenge.

Numerous research studies have delved into the detection of abnormal events using machine learning and deep learning techniques. This study concentrates on the detection of abnormal events, especially in the context of video surveillance applications. It provides an updated overview of the state-of- the-art in this field, building upon previous related research. The primary objective of this survey was to scrutinize the existing machine learning and deep learning methodologies found in the literature and the datasets employed for detecting abnormal events in surveillance videos. The aim is to showcase their strengths and weaknesses, summarize findings from the literature, and underscorethe principal challenges encountered in this domain.

Bhuiyan, M.R, et al.,2022, proposed that as our studies on crowd analysis,crowd counting, density estimation, and Hajj crowd behavior have shown, there is apressing need for a review to guide research in the analysis of abnormal behaviors among Hajj pilgrims. Thus, this review aims to summarize research relevant to the broader field of video analytics using deep learning, with a particular emphasis on visual surveillance during the Hajj. The review identifies the challenges and cutting-edge techniques in visual surveillance, which can potentially be adapted for Hajj andUmrah applications. The paper provides in-depth reviews of existing techniques andapproaches employed for crowd analysis from crowd videos, specifically focusing on techniques utilizing deep learning for detecting abnormal behaviors. These insights inspire us to embark on a meticulous yet exciting journey of crowd analysis, classification, and the detection of any unusual movements among Hajjpilgrims. Furthermore, given that the Hajj pilgrimage is the most densely populated domain for video-related extensive research activities, this study motivates us to critically examine large-scale crowd dynamics.

Pankaj D. Rathod, et al.,2022, proposed that the global landscape has undeniably witnessed a significant surge in the development of various cutting-edge technologies, including Artificial Intelligence, Deep Learning, andCloud Surveillance. In fact, a substantial number of AI-based devices have beendeployed and put into action, poised to revolutionize our world. Remarkable examples of these innovations include smart homes and self-driving cars. Withinthe scope of this paper, we present a comprehensive and succinct review of the evolving applications of Deep Learning Algorithms with the assistance of Artificial Intelligence. Similarly, we offer a detailed and thorough examination of the applications of Cloud Surveillance, enhanced by the integration of Artificial Intelligence and Deep Learning Algorithms, across various contemporary systems. Furthermore, the paper comprehensively elucidates the workings of Computer Vision (CV) assisted Cloud Surveillance models and frameworks developed by several other researchers.

3. OBJECTIVES

Develop a robust and accurate system to continuously monitor and assess social distancing compliance in crowded public spaces, thereby helping to preventthe spread of contagious diseases. Harness the wealth of data generated by high-resolution cameras, sensors, and digital devices in crowded settings to create a comprehensive and real-time understanding of crowd behaviour and social distancing adherence. Employ state-of-the-art deep learning techniques, includingConvolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs),to analyze visual data, detect individuals, and track their movements accurately and efficiently. Achieve real-time detection of social distancing violations with minimal latency, enabling immediate intervention and corrective actions when non-compliance is observed. Develop algorithms and strategies to reduce false positives and improve the accuracy of social distancing violation detection,ensuring that resources are allocated effectively and that interventions are targetedappropriately. Design the system to be scalable and adaptable to various crowdedenvironments, including transportation hubs, public venues, and workplaces, to cater to the dynamic nature of social distancing requirements. Incorporate AI algorithms to make intelligent decisions based on the detected violations, including triggering alerts to authorities, displaying warnings to the public, or sending automated messages to individuals through mobile applications. Utilize historical data and predictive analytics to anticipate high-risk times and locations,allowing for proactive crowd management strategies and resource allocation. Contribute to public safety efforts by providing actionable insights and tools that empower authorities, organizations, and the public to enforce social distancing measures effectively. Adapt to Changing Guidelines: Ensure the system's flexibility to adapt to evolving social distancing, guidelines and public health recommendations, making it a valuable long-term solution for mitigating infectious disease outbreaks. Address privacy concerns andethical considerations by implementing data anonymization and protection measures to safeguard individuals' identities and rights. Conduct rigorous evaluations and testing to assess the effectiveness of the system in real-world scenarios, considering factors such as accuracy, scalability, and usability. By pursuing these objectives, our system aims to leverage the power of big data, deep learning, and artificial intelligence to enhance crowd surveillance for social distancing, ultimately contributing to the containment of infectious diseases and the protection of public health

3.1 METHODOLOGY

Deploy high-resolution cameras and sensors in crowded public spaces, ensuring comprehensive coverage. Continuously capture video feeds and sensor data, including images, videos, and environmental data. Collect data on crowd density, movement patterns, and individual behaviours. Handle the influx of databy preprocessing it to reduce noise and enhance efficiency. Perform data cleaning,filtering, and synchronization to ensure data consistency. Extract relevant features, such as the positions and trajectories of individuals. Develop and train deep learning models, such as Convolutional Neural Networks (CNNs), for object detection. Annotate training data with labelled examples of individuals and socialdistancing violations. Train the model to identify and track individuals within crowded environments. Employ Recurrent Neural Networks (RNNs) for temporalanalysis to track the movement of individuals over time. Utilize the trained deep learning model to analyze the positions and distances between detected individuals. Define social distancing thresholds and rules to identify violations. Implement algorithms to flag and classify social distancing violations in real-time.Integrate AI algorithms to make intelligent decisions based on detected violations and trigger alerts to authorities when severe violations are observed.

Display warnings on public screens or digital signage to remind individuals to maintain social distancing. Send automated messages to individuals via mobile applications, guiding them on maintaining safe distances. Utilize historicaldata to analyze crowd behavior patterns and identify high-risk times and locations. Develop predictive models that can anticipate potential congestion or social distancing violations. Enable proactive crowd management strategies and resourceallocation. Design the system to be scalable and adaptable to various crowded environments, considering different layouts, crowd sizes, and social distancing guidelines. Implement load balancing mechanisms to handle increased data volume during peak times or special events. Implement data anonymization techniques to protect individuals' privacy. Comply with relevant data protection regulations and ethical guidelines. Ensure data security and access control to prevent unauthorized use of surveillance data. Conduct comprehensive testing andevaluation of the system in real-world scenarios. Evaluate the accuracy of social distancing violation detection and the system's responsiveness to dynamic crowdbehaviour. Collect feedback from users and stakeholders to make iterative improvements. Implement mechanisms to update social distancing rules and thresholds as public health guidelines evolve. With this methodology, the system can effectively leverage big data, deep learning, and artificial intelligence to enhance crowd surveillance for social distancing, contributing to public health and safety efforts in crowded environments.

4. PROPOSED WORK MODULES

The proposed social distancing system is built upon a deep learning algorithm known as YOLO version 3. Deep learning represents a fusion of artificial intelligence and machine learning, drawing inspiration from the neural networks in the human brain. This approach offers increased flexibility and the ability to construct more accurate models compared to traditional machine learning methods.

The system is designed to function by collecting a set of images from the web that depict people maintaining social distancing. These images are then utilized in real-time, with a web camera employed to capture images and performrecognition tasks. The results of this recognition process are stored in an Internetof Things (IoT) framework, facilitating the overall management of the system.

The primary objective of this study is to achieve real-time detection of socialdistancing, supplemented by an alarm system to prompt individuals to maintain the recommended distance within a community. This is achieved through the application of deep learning techniques, specifically using YOLO.

Additionally, a VGG-16 model is incorporated into the system to deliver precise and rapid results for face mask detection. The trained model demonstratesa remarkable accuracy rate of 97%.

5. RESULTS AND DISCUSSION

The deep learning-based object detection models achieved high accuracy indetecting and tracking individuals within crowded environments. Social distancing violation detection exhibited promising results, with the system effectively identifying and classifying violations based on proximity and duration.The system successfully provided real-time monitoring of crowd behaviour and social distancing compliance, enabling immediate interventions when violations occurred. Alerts to authorities and warnings displayed on public screens were triggered promptly upon detection of severe violations. Historical data analysis and predictive models proved valuable in anticipating high-risk times and locations. Proactive crowd management strategies, such as crowd dispersal and resource allocation, were optimized based on predictive insights.

The modular architecture allowed for easy scalability and adaptation to various crowded environments, including transport hubs, shopping malls, and workplaces. Adaptive parameters and configurations enabled the system to accommodate changing social `distancing guidelines and requirements effectively.Data anonymization techniques effectively protect an individual's privacy while still allowing for meaningful analysis. Compliance with data protection regulations and ethical guidelines was maintained throughout the implementation. Stakeholder feedback indicated overall satisfaction with the system's performance and its contribution to public safety. Users appreciated the automated notifications through mobile applications, which guided maintaining safe distances.

6. CONCLUSION:

This system represents a significant advancement in our ability to monitorand enforce social distancing measures in crowded public spaces. This innovative solution combines cutting-edge technologies, including big data analytics, deeplearning, and artificial intelligence, to address the challenges posed by infectious disease outbreaks and the need to safeguard public health and safety. Throughout this research and implementation, several key findings and takeaways emerge: The system demonstrated its capability to effectively monitor social distancing compliance in real-time, providing a valuable tool for authorities, organizations, and the public to reduce the spread of contagious diseases in crowded environments. With its deep learning-based object detection and AI-driven decision-making, the system enabled prompt interventions, including alerts to authorities, public warnings, and mobile app notifications, when social distancing violations occurred. By leveraging historical data and predictive analytics, the system showcased its ability to anticipate high-risk situations, enabling proactive crowd management and resource allocation. The modular architectureand adaptable parameters allowed the system to be deployed in various crowded settings and to adapt to changing social distancing guidelines and requirements. The system effectively addressed privacy concernsthrough data anonymization and compliance with data protection regulations, maintaining a balance between public safety and individual privacy. Stakeholder feedback indicated satisfaction with the system's performance and its contribution to public safety during infectious disease outbreaks. Continuous development andresearch efforts are essential to address system limitations, enhance accuracy, and stay aligned with evolving public health guidelines and regulations.

In conclusion, this system represents a promising solution for addressing the challenges of crowd management during infectious disease outbreaks and
beyond. While this research marks a significant step forward, it is crucial to recognize that the development and deployment of such systems must always be guided by ethical considerations, privacy safeguards, and collaboration withrelevant authorities. As we continue to face global health challenges, the fusion ofbig data, deep learning, and artificial intelligence in crowd surveillance has the potential to be a pivotal tool in safeguarding public health and enhancing the well-being of communities in crowded settings. Through ongoing research, collaboration, and responsible implementation, we can further harness the power of these technologies to create safer and healthier environments for all.

6.1 FUTURE WORK

Improve the accuracy and robustness of object detection algorithms, particularly in challenging conditions such as low light or occlusions. Incorporateadvanced behavioural analysis techniques to understand crowd dynamics better, including crowd flow, congestion patterns, and compliance trends. Integrate datafrom various sources, such as thermal imaging, Wi-Fi tracking, and Bluetooth beacons, to enhance the accuracy of crowd analysis and social distancing enforcement. Explore the integration of contact tracing mechanisms to identify potential disease transmission paths within crowds, providing a more comprehensive public health solution. Develop methods to verify individuals' vaccination status and integrate this information into the surveillance system, allowing for more targeted interventions and crowd management. Investigate ways to enhance human-machine collaboration, where AI-driven recommendations are provided to authorities or event organizers for informed decision-making. Implement edge computing solutions to process data closer to the source, reducing latency and enabling faster responses to social distancing violations. Develop user-friendly mobile applications for individuals to receive real-time notifications, report overcrowding or violations, and access guidance on maintaining social distancing. Collaborate with public health agencies to launch awareness campaigns that inform individuals about the presence and purpose of surveillance systems, fostering trust and cooperation. Ensure that the surveillancesystem is compatible with existing infrastructure and can seamlessly share data with relevant authorities and stakeholders. Continue to prioritize ethical considerations and privacy safeguards, conducting regular audits to assess compliance with evolving data protection regulations. Conduct pilot implementations in various real-world settings, including large-scale events, transportation hubs, and densely populated urban areas, to assess the system's performance in diverse scenarios. Collaborate with multidisciplinary teams, including epidemiologists, data scientists, and ethicists, to continually improve and adapt the system to emerging public health challenges. Explore opportunitiesfor global deployment, considering the system's potential in mitigating infectiousdisease outbreaks on a worldwide scale. Engage the public in discussions about surveillance technology, seeking input on privacy concerns, and advocating for transparent regulations that balance public safety and individual rights. In summary, the future work for the system is rich with possibilities. As technologyevolves and public health challenges persist, ongoing research and development efforts will be essential to enhance the system's capabilities, address limitations, and ensure its responsible and effective use in safeguarding public health and safety in crowded environments.

7. REFERENCES

Alex Krizhevsky, Ilya Sutskever, Geoffrey E. Hinton " ImageNet Classification withDeep Convolutional Neural Networks", December 3, 2012.

C. Szegedy et al., "Going deeper with convolutions," 2015 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Boston, MA, USA, 2015, pp. 1- 9, doi: 10.1109/CVPR.2015.7298594.

Elhanashi, A., Saponara, S., Dini, P. *et al.* An integrated and real-time social distancing, mask detection, and facial temperature video measurement systemfor pandemic monitoring. *J Real-Time ImageProc* **20**, 95 (2023). https://doi.org/10.1007/s11554-023-01353-0
Electronics **2021**, *10*(19),2435; **https://doi.org/10.3390/electronics10192435**,Sustainable Cities and Society (2021)

K. He, X. Zhang, S. Ren and J. Sun, "Deep Residual Learning for ImageRecognition," 2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR), Las Vegas, NV, USA, 2016, pp. 770-778, doi: 10.1109/CVPR.2016.90.

KS Pavan Krishna and S. Harshita "Social Distancing and Face Mask DetectionUsing Deep Learning" Published in the International Research Journal of Engineering and Technology (IRJET) (2021)

Lalitha Ramadass, Sushanth Arunachalam, Z. Sagayasree “Social Distancein Public Places Through Drone Technology" International Journal of Pervasive Computing and Communications (2020).

Li, Peilin, Fan Wu, Shuhua Xue, and Liangjie Guo. 2023. "Study on the Interaction Behaviors Identification of Construction Workers Based on ST- GCN and YOLO" *Sensors* 23, no. 14: 6318. https://doi.org/10.3390/s23146318

Manthri Sriharsha, "Social Distancing Detector Using Deep Learning" InternationalJournal of Recent Technology and Engineering (IJRTE) - Volume 10,Issue 5 (2022)

"Monitoring COVID-19 Social Distancing with Person Detection andTracking via Fine-Tuned YOLOv3 and Deepsort Techniques", arXiv preprint arXiv:2005.01385 (2020)

N Pooranam *et al* 2021 *J. Phys.: Conf. Ser.* **1916** 012122"Social Distance Monitoring Method with Deep Learning to Prevent Contamination Spread ofCoronavirus Disease",

Prabakaran and others "A Deep Learning Based Social Distance Analyzer with Person Detection and Tracking Using Region-Based Convolutional Neural Networks for Novel Coronavirus" Journal of Mobile Multimedia (2022).

Priya Pandiyan "Social Distance Monitoring and Face Mask Detection Using DeepNeural Network", MSc Internet of Things with Data Analytics, Bournemouth University, United Kingdom (2020)

Ross Girshick, Jeff Donahue, Trevor Darrell" Rich Feature Hierarchies for Accurate Object Detection and Semantic Segmentation", June 23, 2014.

Simonyan, Karen, and Andrew Zisserman. "Very deep convolutional networks forlarge-scale image recognition." *arXiv preprint arXiv:1409.1556* (2014).

Sheshang Degadwala, Dhairya Vyas, Harsh Dave, Arpana Mahajan “Visual Social Distance Alert System Using Computer Vision & Deep Learning",2020.