Journal of
Data Acquisition and Processing

ISSN: 1004-9037
https://sjcjycl.cn/
DOI: 10.5281/zenodo.7764710

SMART TRANSPORTATION USING IOT IN SMART CITIES

Vadada Yamuna
PG Research Scholar, Department of Computer Science Engineering, Raghu Engineering College, Dakamarri, Visakhapatnam – 531162, Andhra Pradesh, India.
yamuna.vadada95@gmail.com

Sridevi Gadde
Assistant Professor, Department of Computer Science Engineering, Raghu Engineering College, Dakamarri, Visakhapatnam – 531162, Andhra Pradesh, India.
sridevigadde.85@gmail.com

Ravi Manapuram
ravi.manapuram@gmail.com

Nikhila
nikhilacse@gmail.com

Abstract— Transportation has been a fundamental need for human societies since it first emerged. The development of more advanced modes of transportation over time has resulted in the widespread utilization of rail, road, and air travel. We all recognize that cities face a variety of complicated difficulties; for today's smart cities, the conventional methods used in the past to manage transportation, environmental pollution, and garbage disposal are insufficient. Because of this, smart transportation necessitates the use of modern architecture and technology. To improve the effectiveness of urban infrastructure and services concerning road and people safety, this study employs the smart transportation concept by incorporating cutting-edge technologies such as the Internet of Things (IoT) and Deep Learning (DL). The proposal that was suggested will be implemented in three stages. First, use surveillance camera footage to automatically determine the current traffic conditions. Second, there is constant monitoring of air pollution levels, with alerts generated if anything seems off. Third, the waste management system assists in locating trashcans that have become overflowing. Smart transportation's end goal is to improve people's daily travel experience by utilizing the knowledge gained through the analysis of data gathered by a network of sensors and other electronic gadgets. To display, analyse, and interpret real-time data, all of it must be kept in a location known as the cloud. The mobile app was created to help the general population comprehend traffic, pollution, and waste bin status in their surroundings.
Keywords— Transportation, Cloud, Sensor, Waste Management, Traffic, Pollution, Mobile Application, Deep Learning

I. INTRODUCTION

The novel concept of the IoT is already influencing our regular activities. As a result of people's increased technological connectivity, globalization is advancing and the world is becoming more borderless. New and beneficial services are being created as a result of the internet's ability to connect various forms of electrical equipment. The IoT is an interconnected system of computing gadgets and digital infrastructure that enables remote sensing and manipulation of the real environment. In 2011, there were more Internet-enabled devices than there were people on Earth (12.2 billion vs. 7 billion). By the year 2020, there will be between 26 and 50 billion connected gadgets in use around the globe. By leveraging a wide range of pervasive services, the IoT makes global Smart City rollouts possible. Opportunities such as remote device monitoring and administration, as well as the analysis and utilization of data from several streams of real-time traffic information, have emerged with the advent of IoT. Infrastructure is being upgraded, municipal services are becoming more efficient, road traffic congestion is being reduced, and citizen safety is being bolstered thanks to the IoT. Smart city architects and suppliers know that simply providing a smart city feature isn't enough if they want to fully realize the IoT's promise. Instead, cities need to deliver scalable and secure IoT solutions that integrate successful IoT systems. The United States, China, and South Korea are just a few of the countries that have started making plans for implementing IoT. India doesn't want to fall any more behind. With the federal government proposing INR 48,000 crores in financial support over 5 years and plans to construct 100 smart cities across the country [1], the IoT is positioned to make quick inroads in India.

Several transportation issues afflict contemporary culture. To make headway in resolving these issues, it is necessary to address a wide range of challenges and barriers connected to the transportation system. Congestion mitigation, enhanced security, air quality monitoring, roadside litter collection, the use of cutting-edge technology, the acquisition and protection of resources, and so on are all part of traffic management. The concept of "Intelligent Transportation System" (ITS) relates to "the use of developed sensor, desktop, devices, and telecommunication technologies, as well as management techniques, to transfer data to passengers to enhance the security and effectiveness of road transportation [2]. The goal of an ITS. is to offer specialized assistance in the areas of traffic kinds, pollution, accident prevention, energy saving, and waste management [3]. IoT platforms capable of managing millions of connected devices, systems, and people are essential to any smart city solution [4]. With an emphasis on traffic control, waste management, and air pollution monitoring, the study's goal is to develop an intelligent transportation system for use in "smart cities."

II. LITERATURE SURVEY

The study's [5] goal was to develop an algorithm that would assist vehicles in smart cities in navigating crowded crossings without becoming caught in traffic. To accomplish this, graph-based algorithms consider a variety of dynamic characteristics to calculate the shortest feasible diversions. Possible criteria include the differential distance, congestion factor, and traffic density on route segments. When traffic congestion is detected in a smart city, it is resolved using graph-based algorithms. The paper covers the congestion-avoidance strategy, how it is implemented, and the simulation results.

The research [6] suggests an IoT-based system design for gathering, processing, and storing real-time traffic information. The goal is to make things easier to get to by having roadside message devices report on congestion and other sudden traffic problems in the real world. These earlier alerts will be appreciated by citizens, especially during rush hour. The device also broadcasts the most recent traffic reports from authorities. To determine the model's practicality, a prototype has been put into action, and the results demonstrate significantly low error in road occupancy estimation and high accuracy in vehicle recognition. This study is part of a broader project funded by the Sultanate of Oman that is investigating the use of real-time input to improve the effectiveness of adaptive traffic lights.

The authors of the paper [7] adapt their findings to a real-world scenario, Shiraz City, which relies on a fixed-time traffic signal schedule rather than any form of intelligent technology. To improve traffic light regulation, IoT techniques, and AI procedures were applied. Here, sensors like security cameras were used by the automated traffic signal control technology to gather information on traffic conditions. As a comparison to Shiraz's fixed-time traffic signal control scheduling, the experimental findings show that the suggested technique reduces typical car queue lengths and waiting times at crossings.

The authors of this paper [8] describe the planning and execution of an ML- and IoT-powered Adaptive Traffic-management system (ATM). The proposed system's design is built around vehicles, infrastructure, and events. The design considers a wide range of scenarios to cater to any problems that may develop with the transportation network. The proposed ATM model automatically adjusts the timing of intersection lights based on changes in traffic flow and projected movement. It creates a smoother transition between lights, which results in less traffic and shorter travel times for drivers. Based on the results of the experiments, the suggested ATM system has the potential to be a game-changer for smart cities in terms of transportation strategy. Travelers could expect shorter wait times, less traffic, fewer accidents, and an overall better trip with the proposed ATM solution.

The article [9] created a new intelligent system for waste management using Blockchain and IoT to encourage simpler trash separation through the usage of smart bins. The proposed method employs smart contracts to encourage the proper use of intelligent bins by providing users with benefits for doing so. To gauge how well the prototype would perform in the real world, they deployed it over a wide variety of test networks. Experimental results for the suggested model show that the Matic test network works better than both the Binance Smart Chain and Ropsten test networks. By removing single points of failure, the suggested solution guarantees transparency, traceability, and scalability of the system.

An IoT-based intelligent segregation and maintenance system is proposed in the study [10], which uses sensors including ultrasonic, color, and Servomotors wired with ESP8266 to separate the trash into bio and non-biodegradable waste. For fully enclosed communication, the Node MCU includes an Arduino and a WIFI module. Eliminate the open decay of biowaste and the following proliferation of microorganisms by using programmable IO devices in all stages of garbage processing, from levelling through sorting. The suggested system sorts rubbish into three groups using a color sensor: dry garbage, moist garbage, and electronic waste. The use of this application to sort garbage is an efficient waste management method.

The document [11] describes the design of a battery-powered, low-cost IoT Air Quality monitoring device capable of monitoring air quality for up to 30 hours. The system's interoperability with a specialized Blynk smartphone app, as well as the fact that it could be employed for real-time measurements, ensures simple user engagement. The device uses on-site data to calculate a qualitative air quality index in compliance with US EPA standards. Users can improve indoor air quality by following the system's recommendations, which are based on environmental data and may include ideas such as opening windows and reducing activity. This configuration can serve as a network node in Smart City-scale air quality monitoring networks.

The study [12] describes how to estimate pollution for any given day using the IoT. This research aims to demonstrate that intelligent air pollution monitoring systems can benefit from the incorporation of data gathered from sensors to improve pollution control efforts. The process gathers data from the sensor, transfers to the server, and stores it in a SQL database. To forecast outcomes, they employ a linear regression method. Artificial intelligence technology has the potential to improve health and cut healthcare costs by proactively lowering pollution and identifying key sources of air pollution.

III. PROPOSED IDEA

The research tries to make the transportation system more intelligent with the help of IoT. For smart transportation, many factors are involved. In this research, we have taken three important things such as traffic detection, waste management, and pollution monitoring. For traffic detection, the CCTV camera is employed. The photos are captured by CCTV and sent to the cloud. In the cloud, we already deploy the DL model to identify the traffic. Next, the MQ sensors are used to monitor the air pollution level in and around the road and send data to the cloud. Finally, waste management is done using an ultrasonic sensor. If the wastage is full the ultrasonic sensor sends Boolean high to the cloud. The NodeMCU is employed as a microcontroller to receive and transmit data to the cloud. The data of all three factors are analysed by the cloud and the mobile app is designed to make those data visible to the people. The overall block diagram of the proposed idea to implement an intelligent traffic system is given in figure 1.

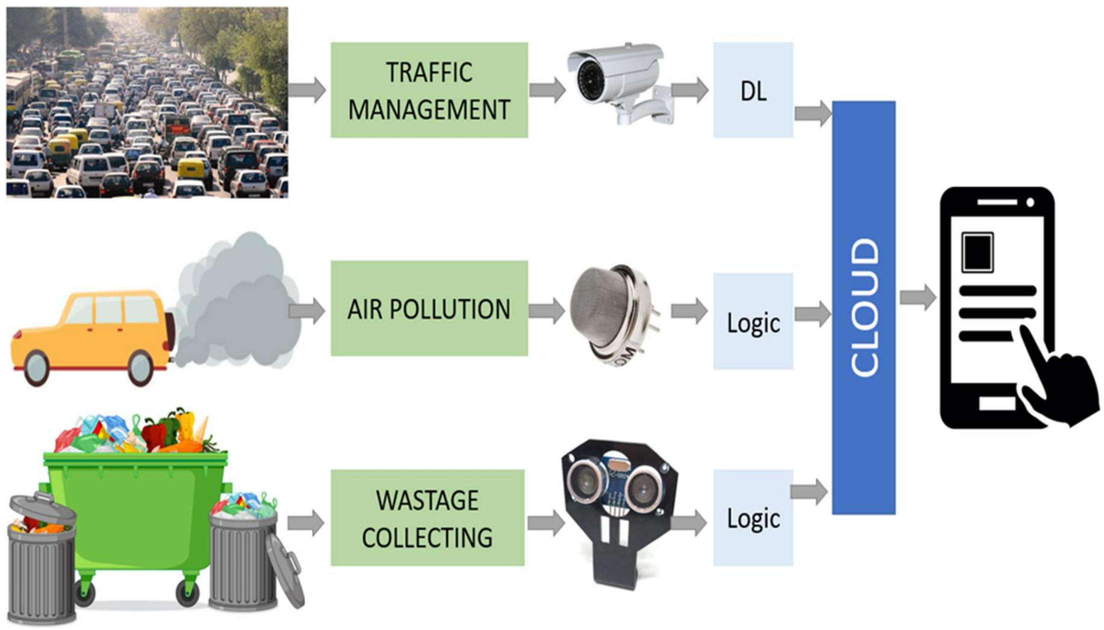


Fig. 1. Block diagram of the proposed idea

A. Traffic Management

The city's traffic system, as one of many interconnected sections, is an important component of the city as a whole. According to a study, it is the foundation of all economies [13]. It is also touted as an important component of the smart city. More people on the road equals greater automobiles on the road, which means more traffic jams. Traffic jams in major cities are not only a waste of time but also a breeding environment for criminal activities, such as cell phone theft at stoplights. However, it hurts industrial efficiency as well as the environment. As a result, proactive traffic control is essential. The majority of countries employ time-based signals to govern traffic, although big cities in certain affluent countries use computerized, centralized systems. In this research, we deploy advanced technologies like IoT, and DL to identify the traffic status around 5km. The CCTV camera is used to capture images of the road and send photos to the cloud. In the cloud, we already employed the CNN model. The CNN model [14] can able to identify whether there is traffic present in that area or not by analysing the images.

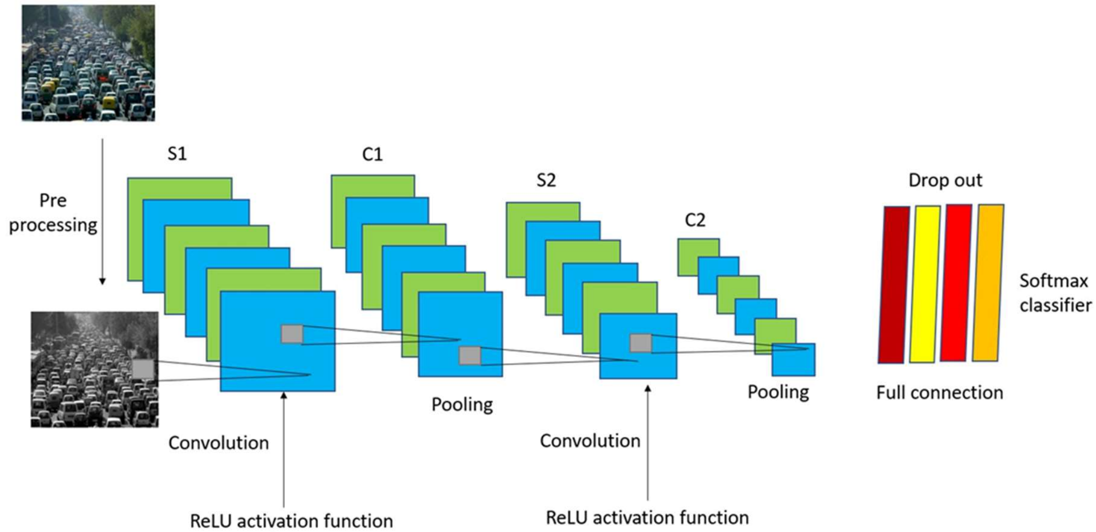


Fig. 2. CNN Architecture for traffic prediction

As seen in Figure 2, the architecture of the CNN model is a series of interconnected nodes and the procedure consists of the following steps:

- Layers should be added in the following sequence: three convolutional layers (CL) and three pooling layers (PL) alternatively, followed by a dropout layer (DL), a flattening layer (FL), and a dense layer.
- The number of filters is set in the CL. The input image is convolutionally processed, and a feature map is produced.
- To produce a corrected feature map, the ReLU uses the maximum function to decrease the negative scores to 0 without affecting positive scores. To minimize the dimension of an image, the PL accepts the corrected feature map and does a down-sampling process (such as Max or average pooling) [15].
- To simplify the outcome of pooling feature maps into a 1-dimensional array, the FL is implemented.
- To prevent overfitting, the DL can be utilized to temporarily disable some of the input nodes. In contrast, the dense layer uses the inputs from the previous layer to train its neurons and then performs matrix-vector multiplication (the row vector of the previous layer must match the dense layer's column vector) to produce an m-dimensional vector.
- Once adding the layers, the model should be compiled (the last stage in the model's construction is to choose the appropriate loss and optimization function). In the designed model, the Adam is employed as an optimizer and cross-entropy is the loss function.
- The next step is to train the model on the training dataset by feeding the pre-processed images. The CCTV obtains the color image of the road, and those images are processed using some techniques like Gray conversion, image resizing, and noise removal.
- In the end, the trained model is used to make predictions on test data, and the outcome includes whether there is traffic or not.

B. Air Pollution Monitoring

In the current period, motor vehicles are the dominant source of air pollution=As the global population grows, so does the number of people driving their cars in cities; both trends have been increasing at an exponential rate over the last decade. Carbon monoxide (CO), nitrogen oxides (NOx), and hydrocarbons are examples of high-level particle air pollutants. The risk of sickness from breathing dirty air increases as pollution levels rise [16]. The general public's health suffers as well. Poor air quality makes it difficult for people to breathe and raises the risk of a variety of illnesses, including cancer. Rising urbanization and industrialization are causing poor air quality. To reduce vehicle-related air pollution, vehicles would need to be continuously monitored. The majority of drivers do not have their automobiles serviced regularly, which exacerbates the pollution problem. The IoT is employed to identify the pollution in the environment. The MQ sensor is chosen by studying the previous research articles to identify the air pollution level. There are many pollutants in the environment, we take tropospheric ozone (O3) Nitrogen Dioxide (NO2), CO, and particulate matter (PM). The sensors collect the pollution data and send it to the cloud. In the cloud, we have already done some basic logical operations. If the pollution level is greater than the threshold, the cloud sends the indication to the mobile app, else the cloud sends the collected data to the mobile app. This can help the public and government to know about the pollutants level emitted by the vehicles are either safe or not for breathing.

C. Wastage Management

The amount of waste created increases in tandem with urbanization, rising incomes, and rising consumption. It's not uncommon these days to see public garbage cans or dustbins straining beneath the weight of the day's waste. Waste has many harmful consequences for both our health and the environment. In addition to health issues, garbage causes environmental damage in the form of air pollution and water pollution, as well as toxic contaminants such as co2, methane, and nitrous oxide. Hazardous waste disposals, such as electronics and plastics, have an indirect effect on human health and aquatic life [17]. Garbage that is not properly disposed of can be a nuisance as well as an eyesore to the general population. Waste also has an effect on vehicle drivers, which can occasionally lead to accidents. The garbage near the roadside should be cleaned properly at regular intervals of time. The ultrasonic sensor is fixed at the top of the garbage bin. The ultrasonic continuously emits sound signals, if the garbage bin is filled, the ultrasonic can detect that based on the signal reception time. The sensor will send those readings to the cloud. The cloud sends the trash filling indication to the mobile app with the garbage bin location. So, it helps the municipalities to identify the filled garbage bin and reduce their work burden.

IV. RESULTS AND DISCUSSION

Smart transportation is built by regulating three important criteria such as traffic, wastage, and pollution using IoT and DL technology. The CNN is built to identify the traffic status. If more vehicles are present in the image the designed model should tell the traffic status as 1 else it should be 0. The CNN model was first trained using the images randomly collected from google with and without traffic. The CNN model performance in the training phase is given in Figures 3 and 4.

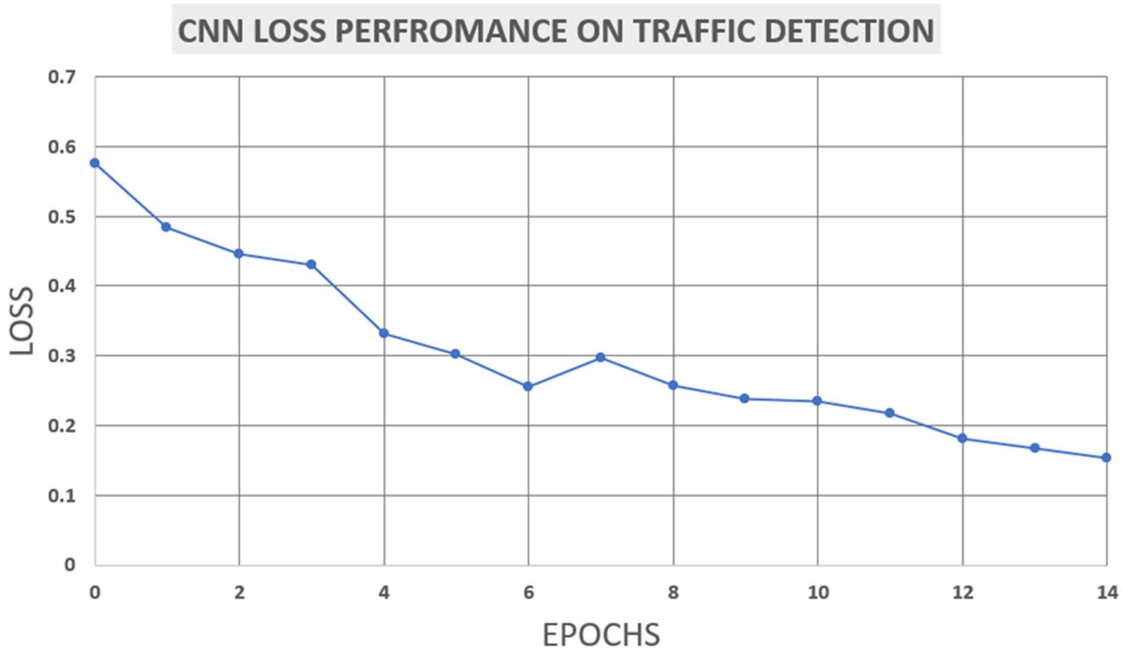


Fig. 3. CNN Loss performance in the training phase

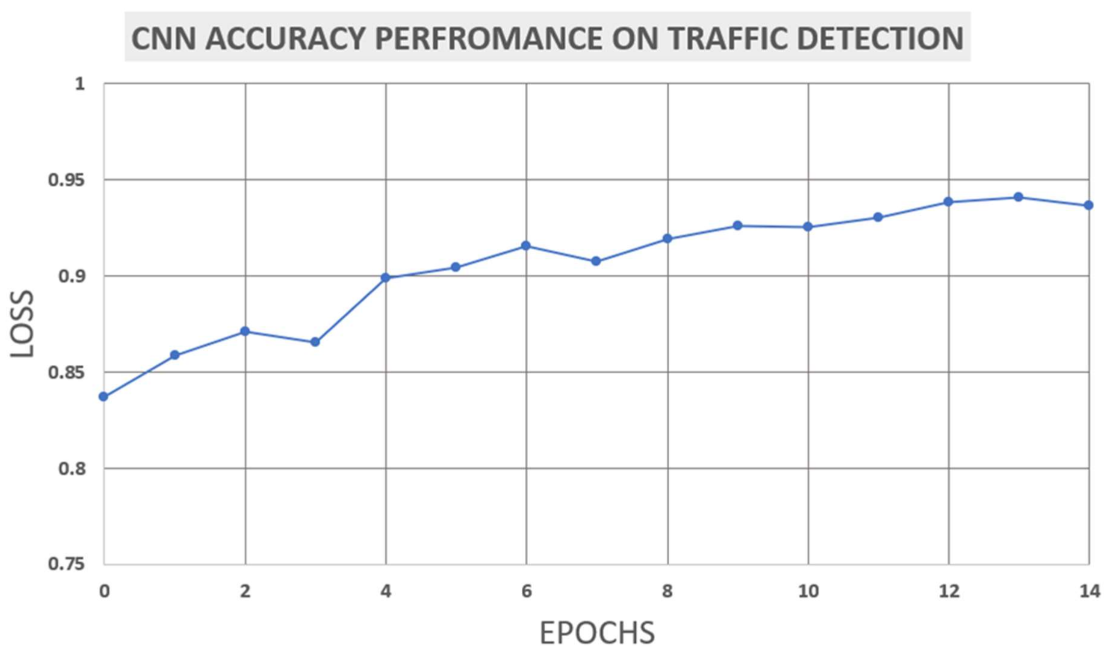


Fig. 4. CNN Accuracy performance in the training phase

The loss performance of figure 3 shows that the number of epochs used for training is 30 and the loss score decreases as the epoch rate increases. The loss starts at 0.59 and ends at 0.15. Similarly, the accuracy plot is also done in figure 4. The accuracy value will be 0.84 at the starting stage of training, as the training epochs raises the accuracy also increase gradually and finally reaches 0.94. In both loss and accuracy plots, there is no fluctuation in the performance. So, we conclude that the designed CNN model is good enough for identifying the traffic status.

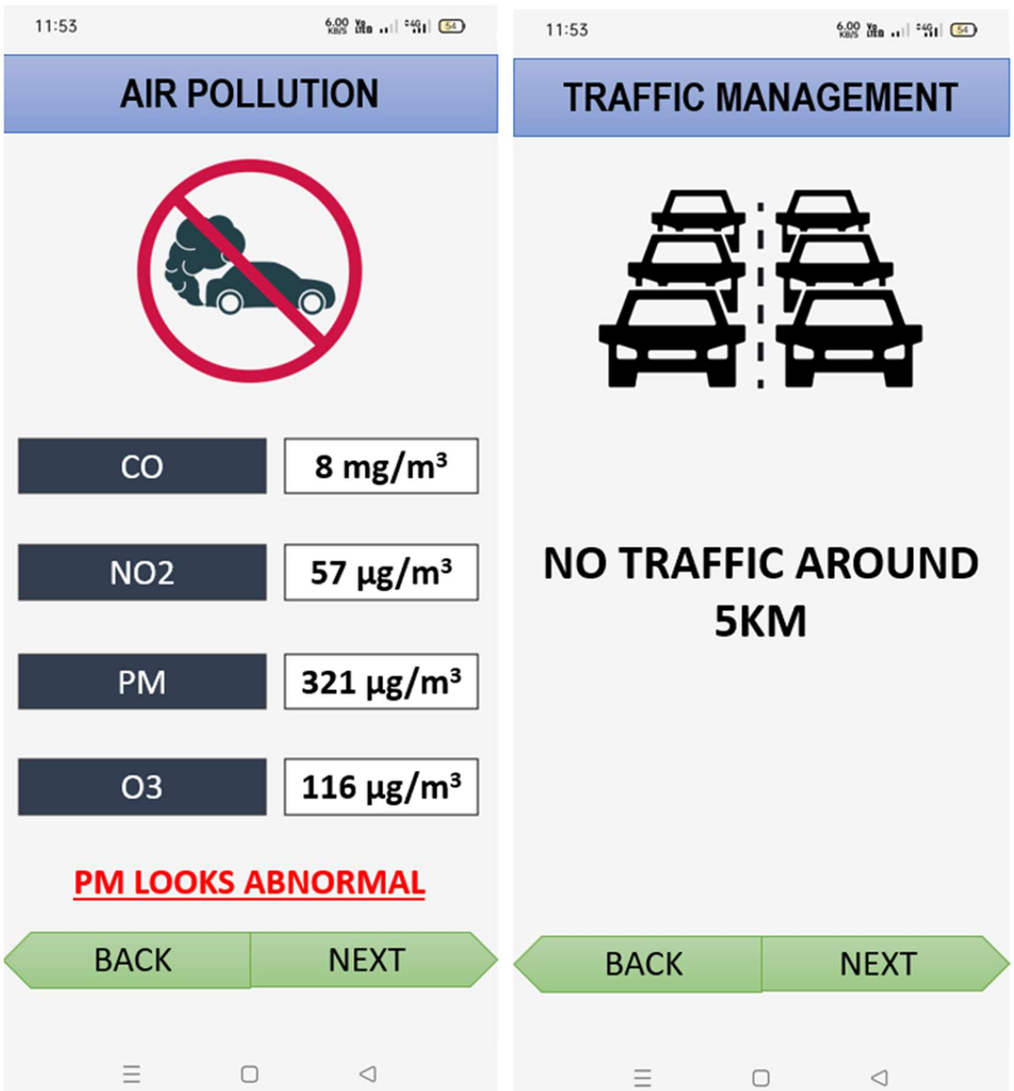
The CNN model for traffic prediction and logical conditions for air pollution and waste management are deployed in the cloud. Next, the mobile app is built to monitor transportation in smart cities. The cloud used in this work is firebase and the MIT APP inventor is utilized to design the mobile app with a simple user interface. The working of the designed mobile app is given in Figures 5 and 6.

(a) (b)

Fig. 5. Working of designed mobile app (Part I)

In figure 5, the home page and the working wastage management page are illustrated. On the home page (figure 5.a), we have three options traffic, waste management, and pollution. The user can select the options based on their need, if the user selects waste management, the page visible to the user is shown in figure 5.b. The page will show the status of the garbage bin. If the bin is filled, the app suggests cleaning the bin and the location of the bin is also given on the waste management page.

Next, the working of air pollution monitoring and traffic management is illustrated in Figures 6.a and 6.b. The air pollutants like CO, NO2, PM, and O3 values are shown in the figure. If the pollutants are within the threshold level, the mobile app just indicates the value, else the warning message will pop up on the designed page. Next, the working of traffic identification is analyzed. The designed system can check the traffic status around 5KM and update the information in the mobile app. This will helpful for the persons, to reach their desired location at the appropriate time and also helps to avoid extra traffic in those areas.



(a) (b)

Fig. 6. Working of designed mobile app (Part II)

V. CONCLUSION

As time goes on, the idea of "smart cities" gains popularity in the modern world. The backbone of every "smart city" is its public transportation system. Intelligent transport service and infrastructure deployment is a long-game strategy. The benefits of intelligent transportation to the nation will probably not be immediate but they gradually do. IoT has the potential to solve problems like traffic jams, pollution, and trash removal. In this study, smart transportation uses IoT and DL technologies to optimize the system to improve high-quality and stress-free travel while reducing harmful and inconvenient travel experiences. The study's culmination is the development of a smartphone app for intelligent transportation. The developed app will let the user know if there is traffic on their way. Then, the person can see if the air quality is good enough to breathe. The trash cans along the highways can now be monitored and checked. The proposed approach will unquestionably enhance travellers' perceptions of comfort and security. While many data transfer standards have been created for the IoT, most of them are incompatible with one another. Work is required in this area to permit sensor node connectivity and communication using diverse protocols with low power consumption.

REFERENCES

[1]. Sarin, Gaurav. "Developing smart cities using Internet of Things: An empirical study." In 2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom), pp. 315-320. IEEE, 2016.

[2]. Xu, Xiujuan, Yu Liu, Wei Wang, Xiaowei Zhao, Quan Z. Sheng, Zhe Wang, and Bowen Shi. "ITS-frame: A framework for multi-aspect analysis in the field of intelligent transportation systems." IEEE Transactions on Intelligent Transportation Systems 20, no. 8 (2018): 2893-2902.

[3]. Broggi, Alberto, Alex Zelinsky, Ümit Özgüner, and Christian Laugier. "Intelligent vehicles." In Springer Handbook of Robotics, pp. 1627-1656. Cham: Springer International Publishing, 2016.

[4]. Zanella, Andrea, Nicola Bui, Angelo Castellani, Lorenzo Vangelista, and Michele Zorzi. "Internet of things for smart cities." IEEE Internet of Things journal 1, no. 1 (2014): 22-32.

[5]. Zubairi, Junaid Ahmed, Sahar Idwan, Syed Ali Haider, and David Hurtgen. "Smart City Traffic Management for Reducing Congestion." In 2022 IEEE 19th International Conference on Smart Communities: Improving Quality of Life Using ICT, IoT and AI (HONET), pp. 225-230. IEEE, 2022.

[6]. Sarrab, Mohammed, Supriya Pulparambil, and Medhat Awadalla. "Development of an IoT based real-time traffic monitoring system for city governance." Global Transitions 2 (2020): 230-245.

[7]. Damadam, Shima, Mojtaba Zourbakhsh, Reza Javidan, and Azadeh Faroughi. "An Intelligent IoT Based Traffic Light Management System: Deep Reinforcement Learning." Smart Cities 5, no. 4 (2022): 1293-1311.

[8]. Lilhore, Umesh Kumar, Agbotiname Lucky Imoize, Chun-Ta Li, Sarita Simaiya, Subhendu Kumar Pani, Nitin Goyal, Arun Kumar, and Cheng-Chi Lee. "Design and implementation of an ML and IoT based Adaptive Traffic-management system for smart cities." Sensors 22, no. 8 (2022): 2908.

[9]. Paturi, Mohinish, Sampath Puvvada, Badhari Sai Ponnuru, Mounika Simhadri, Bhaskara S. Egala, and Ashok Kumar Pradhan. "Smart solid waste management system using blockchain and iot for smart cities." In 2021 IEEE International Symposium on Smart Electronic Systems (iSES)(Formerly iNiS), pp. 456-459. IEEE, 2021.

[10]. Leo, L. Megalan, S. Yogalakshmi, A. Jerrin Simla, R. Thandaiah Prabu, P. Sathish Kumar, and G. Sajiv. "An IoT Based Automatic Waste Segregation and Monitoring System."

In 2022 Second International Conference on Artificial Intelligence and Smart Energy (ICAIS), pp. 1262-1267. IEEE, 2022.

[11]. Esfahani, Siavash, Piers Rollins, Jan Peter Specht, Marina Cole, and Julian W. Gardner. "Smart city battery operated IoT based indoor air quality monitoring system." In 2020 IEEE SENSORS, pp. 1-4. IEEE, 2020.

[12]. Catovic, Amar, Esad Kadusic, Christoph Ruland, Natasa Zivic, and Narcisa Hadzajlic. "Air pollution prediction and warning system using IoT and machine learning." In 2022 International Conference on Electrical, Computer, Communications and Mechatronics Engineering (ICECCME), pp. 1-4. IEEE, 2022.

[13]. W. S. Associate, "Transportation and Economy Report," MDOT State Long¬Range Transportation Plan, Karachi, 2007.

[14]. Ciregan, Dan, Ueli Meier, and Jürgen Schmidhuber. "Multi-column deep neural networks for image classification." In 2012 IEEE conference on computer vision and pattern recognition, pp. 3642-3649. IEEE, 2012.

[15]. Wang, Yingying, Yibin Li, Yong Song, and Xuewen Rong. 2020. "The Influence of the Activation Function in a Convolution Neural Network Model of Facial Expression Recognition" Applied Sciences 10, no. 5: 1897

[16]. Contreras-Castillo, Juan, Sherali Zeadally, and Juan Antonio Guerrero-Ibañez. "Internet of vehicles: architecture, protocols, and security." IEEE internet of things Journal 5, no. 5 (2017): 3701-3709.

[17]. Mahajan, Kanchan, and J. S. Chitode. "Waste bin monitoring system using integrated technologies." International Journal of Innovative Research in Science, Engineering and Technology 3, no. 7 (2014).