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A Review on the role of Machine Learning for Smart Cities

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ABSTRACT

World population is rising at a rapid-fire pace and is anticipated to touch 10 billion by the time 2035. Rising population makes the job of the external departments and the government dedicates so tedious with limited resources available. As urbun areas face adding challenges related to population growth, resource operation, and sustainable development, the concept of smart cities has surfaced as a trans-formative result. Smart cities influence technology and data to produce intelligent, connected, and sustainable urban ecosystems.The goal of smart cities is to duly manage to expand urbanization, reduce energy operation, enhance the profitable and quality of life of the locals while also conserving the terrain conditions, and improve people's capability to use and adopt ultramodern technology used in information and communication efficiently. Information and communication technology(ICT) is central to the conception of smart cities because it facilitates the development of programs, decision making, perpetration and ultimately the provision of useful services. This review's main idea is to examine how Internet of things(IOT), and machine learning(ML) are advancing smart cities. In moment's ultramodern world, with the advancement of technologies like Internet of things(IOT) and machine learning(ML), applications have become smarter and connected devises give rise to their exploitation's in all aspects of a smarter smart city. Fast urbanization has achieved inconceivable difficulties to our everyday lives, for illustration, business clog, natural impurity, vitality application, and open security. IOT with ML combines as smart technology that plays an important part in intelligent parking system, public safety, transportation , smart business administration, water operation plan, smart road lights,hospitals, roads etc. to examine, manage and control the resources of the smart city.This paper proposes smart city operations with the help of ML and IOT. In addition, the concepts and assessments of various Machine Learning algorithms for respective applications are also presented. Overall, the use of machine learning to leverage IOT based approaches have only proven to be more accurate, sensitive, cost-effective, and time saving.

KEYWORDS: *Smart cities, Machine Learning, Internet of things, Machine learning applications*

1. INTRODUCTION

Smart cities are technologically ultramodern urban areas that gather electronic data from residents, assets, and devices in order to manage available resources more effectively. The main purpose of a smart city is to optimize and promote further provident and sustainable growth. Smart cities are urban environments that work technology and data to ameliorate the quality of life for their residents, enhance sustainability, optimize resource consumption, and streamline smart city operations.By integrating IOT devises and networks, smart cities collect and dissect data from colorful sources to make informed opinions and deliver bettered services.The significance of smart metropolises lies in their implicit to attack colorful civic challenges. With the maturity of the world's population abiding in metropolises, smart mega city enterprise have come vital for creating inhabitable, sustainable, and inclusive urban spaces. By integrating technology and data- driven results, the main thing of smart cities is to ameliorate effectiveness by optimize the use of resources similar as energy, water, and transportation systems, performing in bettered functional effectiveness and reduced waste. Smart cities Ameliorate Quality of Life, Smart cities concentrate on perfecting the quality of life for their residents. Through IOT, smart cities can enhance public services, including transportation, healthcare, public safety, and waste operation. Intelligent systems and data driven perceptive enable visionary planning and briskly responses to citizen requirements, leading to bettered living conditions. Smart cities prioritize environmental sustainability. By using IOT and data analytics, smart cities can cover and manage energy consumption, reduce carbon emigrations, and apply sustainable practices. Technological Development Digital structure similar as electronic, chemical business, and natural detectors can foster substantial development of technology's geographical and indigenous services. The goods of technology driven smart city development can lead to a wide array of long- term benefits. similar as better connectivity, bettered access to health services, safer and further reliable water inventories, and more. Smart metropolises generally concentrate on public government services being fully accessible online. The vacuity of online government services can insure that a smart cities operations are affordable and transparent but can also insure that citizens laboriously share in the unborn development of original services using online feedback and support. One of the biggest challenges of ultramodern metropolises is addressing adding business situations and consequent safety enterprises. thus, smart city results similar as intelligent business operation, smart parking, and other arising technologies can help reduce business rates using prophetic analysis. As well as insure that original citizens can safely pierce their smart cities executive services within a reasonable walking distance and further Secure Public Spaces stir sensors and videotape surveillance technology can help smart metropolises reduce crime rates and reduce the threat of natural disasters in specific public spaces to cover original citizens and raise the overall standard of living of the geographical area in question. Smart city results can also help develop and apply systems to address and help implicit safety enterprises. . By enforcing smart smart city technology that can track energy operation, descry destruction and reduce electricity conditions. Digital detectors can also measure and address air pollution situations, wildlife protection, water resource operation, energy consumption, and much further. This not only encourages sustainable smart city development but is also more affordable in the long run.

Around the world, smart cities are looking for ways to further develop with the help of technology, and one option is collecting data of a smart cities diurnal conditioning for analysis. This information can come from security cameras, smartphones, electronic checks, In this way, a smart cities services can be optimized by assaying and chancing patterns in the collected data. For illustration, depending on the viscosity of business at a particular hour, business lights could be strategically placed and controlled to avoid business logjams. There's also the possibility of automatically determining the right temperature and moisture for a hothouse grounded on factory and environmental conditions.Once the data has been stored, it's reused and can be used to design a machine learning (ML) model that finds patterns in the data. ML along with IoT are essential factors of smart cities. The conception of a smart city implies using technology and data analysis to optimize services in different areas similar as communication, husbandry, public services, among others to enhance reside-rs quality of life. The study focuses on the achievements and variety of operations of smart cities and societies exercising ML approaches to give a comprehensive overview of the ultramodern systems offered by these technologies. This paper addresses a variety of enterprises regarding the use of ML approaches in the operation of smart metropolises and societies. The main idea of this review is to offer a better understanding of 1)Internet of things and smart city 2) Basics of Machine learning 3) List of Popular Machine Learning Algorithms 4)The most recent developments and operations in this field of ML like Healthcare system, accident detection system ,parking management system.

2. INTERNET OF THINGS AND THE SMART CITY

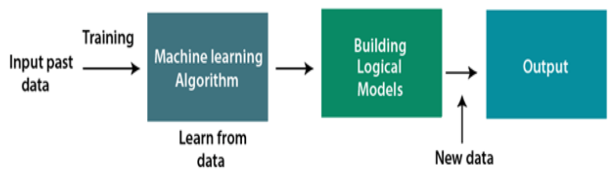
The Internet of Things (IOT) is nothing but the network of physical objects, like devices, vehicles, and buildings, they are embedded with sensors, software, and connectivity, in order to collect and exchange data. These connected devices can communicate with other devices and systems, as a result they can share data share data with one another. smart city and IOT are being used to efficiently challenge the ongoing demands for resources of so many residents living, working, driving, and interacting with each other. IOT and smart city initiatives are mainly used in the improvement of traffic management, energy consumption, public safety, healthcare, etc .In present wired cities, everything is interconnected, from cars, buildings, and home appliances to sensors and smart grid technology for the sake of distribution of electricity, improved integration of energy sources and improved management systems. Most importently citizens can engage with smart cities using their smartphones or connected cars or homes. Pairing devices and data improves sustainability and reduces costs so not only the residents benefit but also for the sake of environment.

Smart cities along with IoT, communities can distribute energy more efficiently, streamline the waste collection, relieve traffic congestion, and enhance air quality. For example, sensors may be attached to rubbish bins to track how full they are and more effectively schedule disposal, and also the use of sensors connected to traffic lights to decrease road congestion. The data from sensors and moving vehicles allow for changing the timing and cadence of their lights in response to traffic in real time.The main goal of smart cities is to incorporate sustainable environment. Incorporation of energy sources and efficient transportation systems, like EV vehicles or bike-sharing programs are some of the examples that boost sustainable mobility. Data acquired from these devices are kept on servers or in the cloud to increase the efficiency of the public and private sectors, improve citizen lives, and bring about economic benefits.IoT and machine learning together used as key technologies for enabling smart city solutions that believe on large-scale data collection, analysis, and decision-making.

3. BASICS OF MACHINE LEARNING

In the real world, we are surrounded by humans who can learn everything from their experiences with their learning capability, and we have computers or machines which work on our instructions. But can a machine also learn from experiences or past data like a human does? So here comes the part of Machine Learning.Without being explicitly programmed, machine learning enables a machine to automatically learn from data, improve performance from experiences, and predict things.

Machine learning algorithms create a mathematical model that, without being explicitly programmed, aids in making predictions or decisions with the assistance of sample historical data, or training data. For the purpose of developing predictive models, machine learning brings together statistics and computer science. Algorithms that learn from historical data are either constructed or utilized in machine learning, machine learning system builds prediction models, learns from previous data, and predicts the output of new data whenever it receives it. The amount of data helps to build a better model that accurately predicts the output, which in turn affects the accuracy of the predicted [15]



A. Classification of Machine Learning

1. Supervised learning
2. Unsupervised learning
3. Reinforcement learning

1) **Supervised Learning**:In supervised learning, sample labeled data are provided to the machine learning system for training, and the system then predicts the output based on the training data.The system uses labeled data to build a model that understands the datasets and learns about each one. After the training and processing are done, we test the model with sample data to see if it can accurately predict the output.The mapping of the input data to the output data is the objective of supervised learning. Supervised learning can be grouped further in two categories of algorithms, Classification, Regression

2)**Unsupervised Learning**: Unsupervised learning is a learning method in which a machine learns without any supervision.The training is provided to the machine with the set of data that has not been labeled, classified, or categorized, and the algorithm needs to act on that data without any supervision. The goal of unsupervised learning is to restructure the input data into new features or a group of objects with similar patterns.In unsupervised learning, we don't have a predetermined result. The machine tries to find useful insights from the huge amount of data. It can be further classifieds into two categories of algorithms Clustering,Association

3)**Reinforcement Learning**: Reinforcement learning is a feedback-based learning method, in which a learning agent gets a reward for each right action and gets a penalty for each wrong action. The agent learns automatically with these feedback's and improves its performance. In reinforcement learning, the agent interacts with the environment and explores it. The goal of an agent is to get the most reward points, and hence, it improves its performance.

Machine learning life cycle involves seven major steps, they are mentioned below:[15]

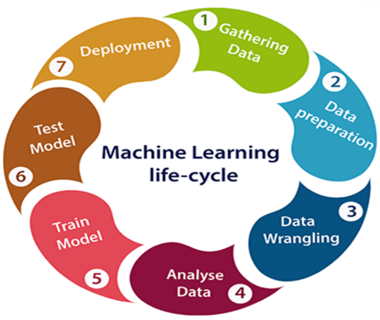


Fig 1: ML Life cycle

3.1 List of Popular Machine Learning Algorithms[16]

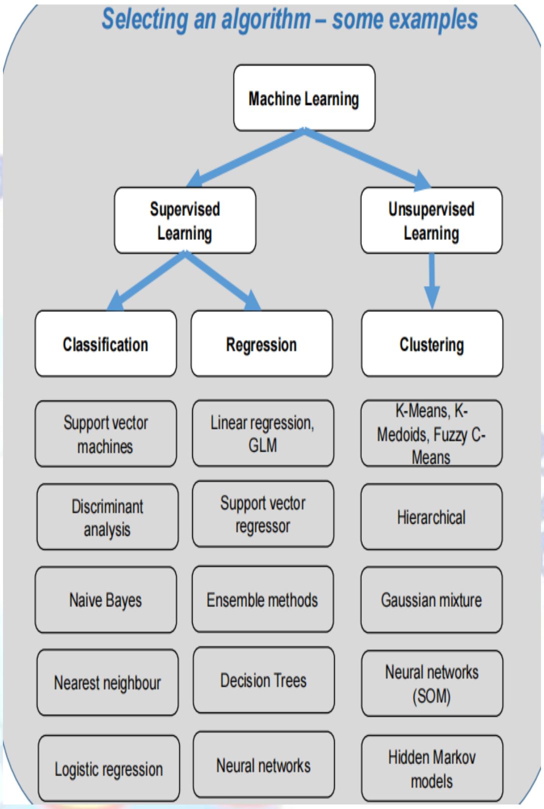


Fig 2:Classification of ML Algorithms

1. Logistic regression

• Fits a model that can predict the probability of a binary response belonging to one class or the other

• Simple – commonly used a starting point for binary classification problems

We can Use this algorithm

• When data can be clearly separated by a single, linear boundary

• Baseline for evaluating more complex classification methods

2. k Nearest Neighbour (kNN)

• Categorizes objects based on the classes of their nearest neighbours in the data set

• Assume that objects near each other are similar

• Distance metrics used to determine nearness (e.g. Euclidean)

We can Use this algorithm

• When you need a simple algorithm to establish benchmark learning rules

• When memory usage and prediction speed is a lesser concern

3. Support vector machine (SVM)

• Classifies data by finding the linear decision boundary (hyperplane) that separates all data points of on class from that of another class

• Points on the wrong side of the hyperplane is penalised using a loss function

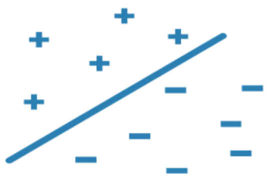
• Uses a kernel transformation to transform non-linearly separable data into higher dimensions where a linear decision boundary can be found

We can Use this algorithm

• Data that has exactly two classes (binary)

• High dimensional, non-linearly separable

• Need a classifier that's simple, easy to interpret, and accurate



4. Neural Network

• Consists of highly connected networks of neurons that relate the inputs to the desire outputs

• Network is trained by iteratively modifying the strengths of the connections so that a given input maps to the correct responses

We can Use this algorithm

• Modelling highly non-linear systems

• Data is available incrementally and you wish to constantly update the model

• There may be unexpected changes in your input data

• When model interpretability is not a key concern

5. Naïve Bayes

• Assumes that the presence of a particular feature in a class is unrelated to the presence of another feature

• Data is classified on the highest probability of its belonging to a particular class

We can Use this algorithm

• Small data set containing many parameters

• Need a classifier that's easy to interpret

• Model will encounter scenarios that weren't in the training data

6. Discriminant analysis

• Classifies data by finding linear combinations of features

• Assumes that different classes generate data based on Gaussian distributions

• Training involves finding the parameters for a Gaussian distribution for each class

• Distribution parameters used to calculate boundaries, which can be linear or quadratic functions

• The boundaries are used to determine new class of data

We can Use this algorithm

• Easy to interpret and generates a simple model

• Efficient – memory usage and modelling speed is fast

7. Decision Tree

• Predict responses to data by following the decisions in the tree from the root down to a leaf node

• Branching conditions where the value of a predictor is compared to a trainer weight

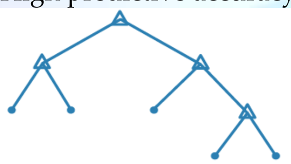
• The number of branches and values of the weights are determined in the training process

We can Use this algorithm

• Need an algorithm that is easy to interpret and fast to fit

• Minimise memory usage

• High predictive accuracy is not a requirement



Regression algorithms:

1. Linear regression

• Used to describe a continuous response variable as a linear function of one or more predictor variables The equation for the regression line is:y= a0+ a*x+ b Here,

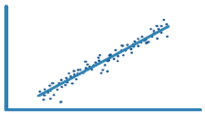
y= dependent variable

x= independent variable, a0 = Intercept of line.

We can Use this algorithm

• Easy to interpret and fast to fit

• Baseline for evaluating other, more complex regression models

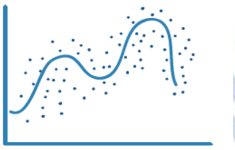


2. Nonlinear regression

- Models described as a nonlinear equation
- Nonlinear refers to a fit function that is a nonlinear function of the parameters

We can Use this algorithm

- Data has strong nonlinear trends and cannot be easily transformed into a linear space
- For fitting custom models to data

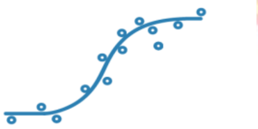


3. Generalised linear model

- Special case of a nonlinear model that uses linear methods
- Involves fitting a linear combination of the inputs to a non-linear function (link function) of the outputs

We can Use this algorithm

- When the response variables have non-normal distributions, such as a response variable that is always expected to be positive



4. Regression tree

- Decision trees for regression are similar to decision trees for classification, but modified to be able to predict continuous responses

We can Use this algorithm

- Predictors are categorical (discrete) or behave nonlinearly

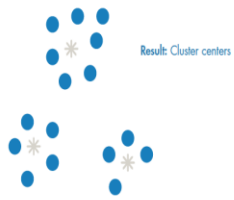
Clustering algorithms

1. k Means

- Partitions data into k number of mutually exclusive clusters
- Determined by distance from particular point to the cluster's centre

We can Use this algorithm

- When the number of clusters is known
- For fast clustering of large datasets



2. k Medoids

- Similar to k Means but with requirement that the cluster centre coincide with the points in the data

We can Use this algorithm

- When the number of clusters is known
- For fast clustering of categorical data
- Large datasets

3. Hierarchical clustering

- Produces nested sets of clusters by analysing similarities between pairs of points
- Grouping objects into a binary hierarchical tree

We can Use this algorithm

- When you don't know how many clusters are in your data
- You want to visualisation to guide your selection

4. Self organising map

- Neural network based clustering that transform a dataset into a topology-preserving 2D heat map

We can Use this algorithm

- To visualize high-dimensional data in 2D or 3D
- To reduce to dimensionality of the data

5. Gaussian mixture model

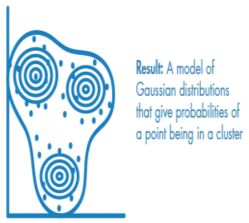
- Partition-based clustering where data points come from different multivariate normal distributions with certain probabilities

We can Use this algorithm

Domain	Algorithms used	Observed clinical data
Ml in Health care	Random Forest Gradient Boosting Machines Logistic Regression ML: Neural Networks	Ethnicity,Age,Atrial Fibrillation, Gender, Smoking, HDL cholesterol, Severe Mental Illness, Atrial Fibrillation, HbA1c Triglycerides, BMI missing Family history of premature CHD, BMI Systolic Blood Pressure,COPD,Total CholesteroL

• When a data point might belong to more than one cluster

• When clusters have difference sizes and correlation structures within them



Machine Learning Algorithms and its usecases:

3.2 The most recent developments and operations in the field of ML

I)Machine Learning in Healthcare System

Machine learning in healthcare is essential as it represents a ground breaking convergence of technology and medicine that has the potential to revolutionize patient care, diagnosis, treatment, and healthcare operations.At its core, machine learning in healthcare involves using algorithms and statistical models to analyze and interpret vast amounts of medical data, facilitating better decision-making and personalized healthcare solutions.There are a wide range of use cases of machine learning in healthcare. From assisting doctors in detecting diseases even before they occur, researching medicines, designing personalized treatment plans, and saving lives

Benefits of ML in health care:

Faster Data Collection:The healthcare industry uses IOT connected medical devices to gather real-time data, which ML can quickly process and adapt to.

Cost-Efficient Process: Machine learning for healthcare helps improve the efficiency and speed of medical services, which can lead to significant cost savings. For example, ML can quickly scan EHRs to manage patient records, schedule appointments, and automate various processes. Predictive Analytics

Patient Education and Engagement: MLdriven chatbots and virtual assistants provide patients with accurate medical information, medication reminders and answer patient queries, enhancing patient engagement and adherence to treatment plans.Using supervised learning to predict cardiovascular disease Suppose we want to predict whether someone will have a heart attack in the future. ◎ We have data on previous patients characteristics, including bio metrics, clinical history, lab tests results, commodities, drug prescriptions ◎ Importantly, your data requires "the truth", whether or not the patient did in fact have a heart attack.[19]

	USE CASE	ML ALGORITHM USED
SMART CITY	Smart health, public safety, smart transportation	Pattern recognition, Semantic reasoning algorithms
	Convenient smart home, real-time traffic routing	Multiagent learning algorithms
	Convenient smart home	Reinforcement learning algorithm
	Smart healthcare	Rule-based algorithm
	Energy, water, agriculture, transportation, healthcare	Semi-supervised deep reinforcement learning algorithms

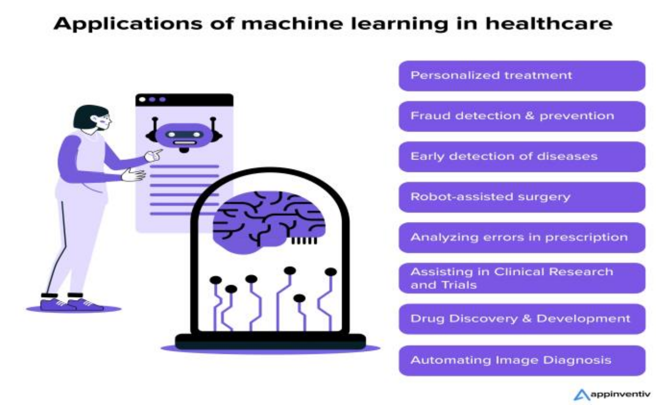


Fig 3: ML applications n health care

3.3. Machine learning in Accident Detection System:[18]

Techniques used:

Artificial Intelligence and Machine Learning (AIML) techniques are crucial in automating accident detection and analysis. These algorithms utilize real-time data from traffic sensors and surveillance cameras to identify accident patterns. By leveraging computer vision techniques, they analyze images and videos to detect sudden changes in vehicle movement and collisions.

Computer Vision

Computer vision, a branch of artificial intelligence, plays a vital role in automating accident detection and analysis. By analyzing visual data from surveillance cameras or sensors, computer vision algorithms extract meaningful patterns and features to identify accidents. Real-time or recorded visual data is analyzed to recognize accident indicators like sudden changes in vehicle trajectories or collisions. Moreover, computer vision enables detailed accident analysis by extracting relevant information from images or video data, including vehicle positions, speeds, and contextual factors. The integration of computer vision facilitates real-time incident identification, and faster emergency response, and provides insights for road safety improvements and traffic management decision making.

YOLO v5

YOLOv8 (You Only Look Once version 8 is a powerful object detection algorithm widely used for accident detection and analysis. It offers real-time and accurate identification of vehicles, pedestrians, and road obstacles. With its high precision and fast processing speed, YOLOv8 efficiently detects accident-related elements in images or video feeds. By leveraging deep neural networks and advanced feature extraction techniques, YOLOv8 recognizes accident patterns, such as sudden changes in movement or collisions. Its integration enhances incident identification, facilitating prompt response and aiding in the analysis of contributing factors. YOLOv8 is a valuable tool for automating accident detection and analysis, contributing to improved road safety and traffic management.

YOLOv8 Configuration Parameters

The YOLOv8 algorithm's configuration parameters are tuned to achieve optimal performance in accident detection.

Key parameters include:

1.Batch Size: The number of images processed in each training batch, affecting memory usage and training speed.

2.Learning Rate: A parameter that controls the step size in the optimization process, influencing how quickly the model converges during training.

3.Anchor Boxes: Pre defined anchor box sizes to facilitate bounding box prediction for objects of different scales.

4.IoU Threshold: IOU-threshold used for filtering out overlapping bounding boxes to improve detection precision.

5.Confidence Threshold: The mini com score required for an object to be considered a valid detection.

6. NMS Threshold: The (NMS) threshold used to eliminate redundant bounding boxes and retain the most confident detections.

Modeling And Analysis

◎1. Data Collection: The process begins with the collection of video streams from road surveillance cameras. These video feeds serve as input data for the YOLOv8 algorithm.

◎2. Preprocessing: Video frames are preprocessed to enhance image quality and reduce noise. Preprocessing includes tasks such as resizing, normalization, and augmentation. YOLOv8.

◎3. Model Initialization: The YOLOv8 model is initialized with pretrained weights obtained from a large dataset. This initialization helps the model learn features effectively.

◎4. Training: The YOLOv8 model is fine-tuned using our labeled data set containing accident images. The training process involves minimizing a loss function by adjusting model weights.

5.Real-time Detection: After training, the YOLOv8 model is capable of real-time accident detection. It processes video frames and identifies accidents by drawing bounding boxes around accident-related objects.

E. Convolutional Neural Network (CNN)

CNNs are Deep Feed forward Neural Networks widely used in computer vision to recognize and classify functions from images. Neural networks execute convolutions and iteratively refine predictions for improved accuracy. This involves repeated convolutional operations on input images to improve recognition akin to human perception. In training, the neural architecture adjusts internal weights using labeled data to minimize prediction-label differences. This iterative learning enhances object recognition. As the network iterates, it captures intricate patterns and visual traits, becoming skilled in generalizing and predicting unseen images. This learning parallels human visual recognition development, relying on diverse training data for robust recognition performance.

The traffic surveillance images or video is sent as an input to the optical flow for describing the image motion. Once the image motion is determined the Motion Interaction field (MIF) is generated for detecting and localizing traffic accidents. Later, MIF is filtered for detecting crashes in surveillance images or videos. The abnormality is measured when the non-symmetrical region with MIF intensity is above the threshold which shows the occurrence of the traffic accident in the video. Through the measured abnormality the accident can be detected and located by mapping the coordinated to the video frame. CNN is having modules like

Convolution ,Activation maps , Kernel Filter, Max Pooling ,activating function, model validation ,model deployment

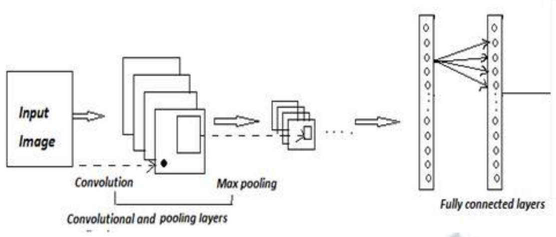


Fig 4: CNN Architecture

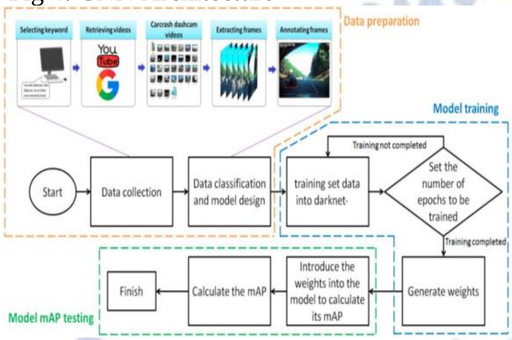


Fig 5: Methodology

4. MACHINE LEARNING IN TRAFFIC FLOW PREDICTION SYSTEM:

The development of data collection technology and sensor technology makes the structure of traffic flow data more and more complex, and also provides a richer data foundation for short-term traffic flow prediction and modelling. Traffic flow data has the characteristics of non-linearity, periodicity, randomness and volatility [6]. Therefore, traditional linear analysis methods are no longer suitable for processing traffic flow data with complex characteristics. Deep learning networks are widely used in short-term traffic flow forecasting due to their strong nonlinear fitting capabilities [8-10]. Methods based on machine learning and deep learning can more effectively and accurately characterize the time-varying characteristics of traffic flow data. Therefore, considering that different traffic flow patterns will affect the short-term traffic flow prediction results, to better explain the complex characteristics of traffic flow and improve the accuracy of short-term traffic flow prediction, this paper proposes a short-term traffic flow prediction method based on deep learning framework.

1) GRU network principle

LSTM [10] adds three sigmoid functions to each small unit to realize the gating function and control the inflow and outflow of data, namely, forget gate, input gate and output gate. The network structure is as follows Figure 1. LSTM can solve the problem of vanishing gradients and exploding gradients, caused by the long-term dependence of RNN. Still, LSTM has three different gates with many parameters, and network training is more complicated.

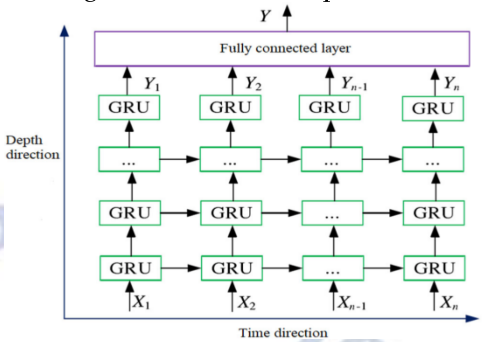


Fig 6: GRU architecture

The GRU network is a variant of the LSTM network. The GRU network also solves long-term dependence and makes numerous simplifications to the LSTM network, which significantly reduces the calculation volume. The GRU network occupies and consumes less memory during training. Therefore, the GRU network has a faster training speed. The GRU and LSTM networks are almost the same [14]. The GRU network has improved the LSTM network mainly in the following two aspects:The forget gate and input gate were combined into a single update gate,The memory unit and hidden states were merged.

The prediction steps of the GRU network

1. Pre-process the acquired short-term original traffic flow data, including deleting null values, identifying abnormal data, and repairing it. Aiming at the missing values in the data, this study uses SPSS software to fill them. The processing method of this study is to treat the outliers as missing values, and use the missing value filling algorithm to repair the outliers;

2. Initialize the network, select the appropriate input variable and time step; 3. Divide the sample data into a training set and a test set, where the data of the test set does not participate in training;

4. The training set will generate a prediction result through the GRU network, which has an error with the real short-term traffic volume. The error value continuously adjusts the weight of the GRU network through the BPTT algorithm. As the number of training iterations increases, the overall network error becomes increasingly more minor, and the prediction results of the GRU will become increasingly accurate;

5. After the GRU network training is completed, each network weight is obtained, and then the test data will be input into the GRU network. The prediction results of the test data will be compared with the actual short-term traffic flow, and the root means square error (RMSE),

average absolute error (MAE), and average absolute percentage error (MAPE) will be calculated to evaluate the prediction performance of the GRU network.

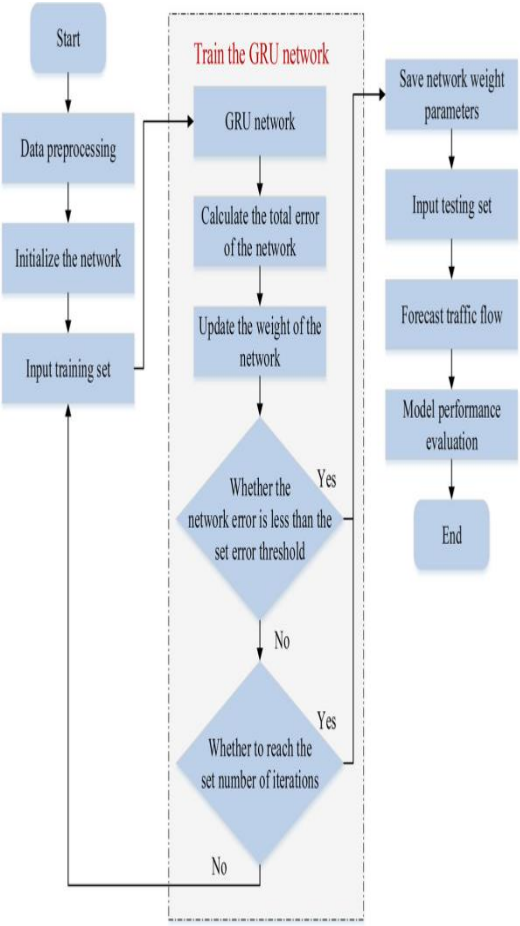


Fig 7 :GRU network prediction steps

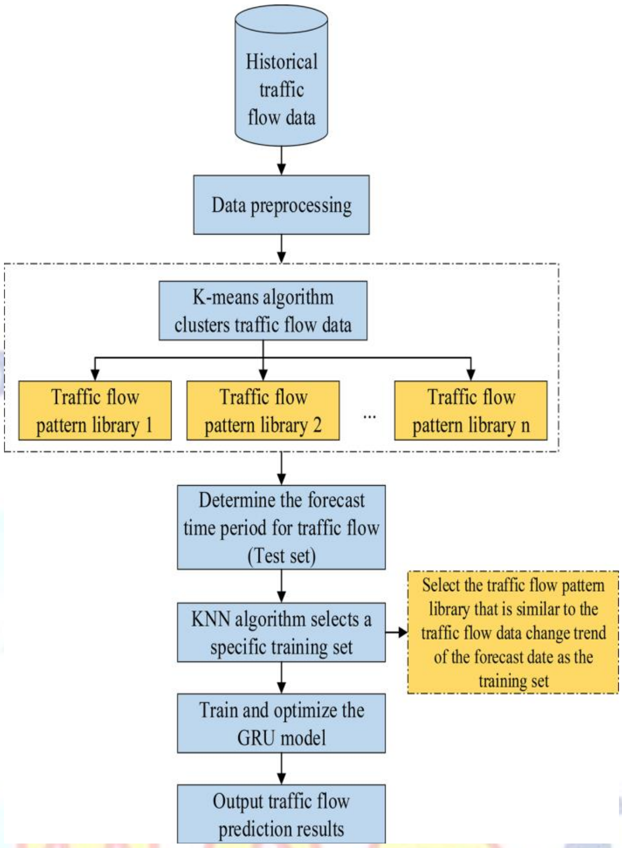


Fig 8 :Short-term traffic flow prediction architecture based on clustering and GRU network

5. MACHINE LEARNING FOR PARKING SYSTEM:

A major problem in metropolitan areas is searching for parking spaces. In this paper, we propose a novel method for parking space detection. Given input video captured by a camera, we can distinguish the empty spaces from the occupied spaces by using an 8-class Support Vector Machine (SVM) classifier with probabilistic outputs. Considering the inter-space correlation, the outputs of the SVM classifier are fused together using a Markov Random Field (MRF) framework. The result is much improved detection performance, even when there are significant occlusion and shadowing effects in the scene. Experimental results are given to show the robustness of the proposed approach. This system consists of four parts: preprocessing, ground model feature extraction, multi-class SVM recognition and MRF based correction. First, we preprocess the input frames and divide them into small patches which contain 3 parking spaces each. Then, a gaussian ground model

is set up to obtain the likelihood of ground for the pixels in the patches as our features. Next, multi-class Support Vector Machine (SVM) is trained to analyze and classify the patches into 8 classes of parking space status. Finally, Markov Random Field (MRF) are builded to solve the conflicts between two neighboring patches in order to improve the recognition accuracy.[17]

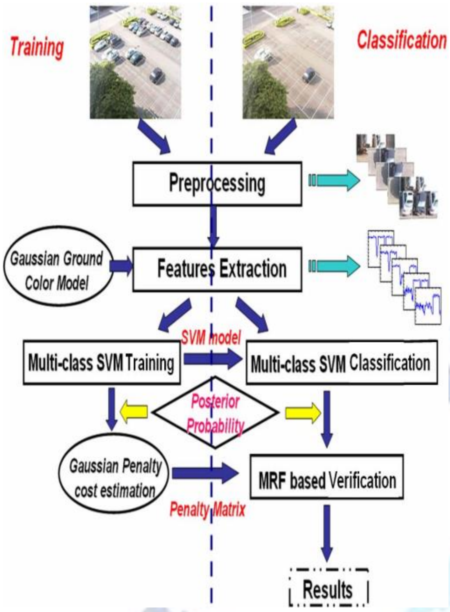


Fig 9 :Methodology

6. CONCLUSION

Machine Learning and IOT has grabbed the attention of academicians and industrialists in the last few years due to the positive effects these two technologies have on people's lives. Machine Learning applications also generate sophisticated visions and ideas, which are provided to IoT systems for service modification and elevation. This paper explored the potential of Machine Learning (ML) for the development of smart cities. With the ever growing use of technology like machine learning will only help to develop much more efficient systems which would have more accuracy in detecting accidents ,parking systems and traffic flow management system.We concisely presented several IOT based machine learning models and their applications such as medical, transport, parking management system. It also presents the basic concepts of some common ML algorithms used and the concept behind it. Finally this review conclude that a combination of ML, IoT, and Big Data offers great potential to the developers of smart city technologies and their services.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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