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SMART TRAFFIC MANAGEMENT SYSTEM

The following are the Technology based Best practices for Traffic Management with Collision Avoidance followed in the countries like China, Japan, United Kingdom and South Korea.

INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

It's an integrated technology (Sensor and AI) enabled traffic coordination control system in urban area to manage mixed traffic and guarantee traffic safety.

Methodology

(i**) 3D - GIS technology** along with Digital HD Multi - mode video surveillance (i.e., IVS – Intelligent Video Surveillance software), 122 Alarms, GPS positioning police and signal control system.

(ii) **Dynamic forecasting technology** - Intelligent Information boards (IIBoard) in roads (both city and fast roads) along with CCTV

Purpose

(i) Efficient monitoring and control of Traffic with significant rapid response capability in case of congestion which covers both the urban trunk roads and expressways.

(ii) Effective traffic management measures like accurate traffic incident, vehicle occupancy, traffic flow detection and monitoring violations.

(iii)IIBoards are used to refresh once every two minutes, and released nearly two million real-time traffic information every day to the public via text, graphics, and video and also broadcast the same by CCTV to TV stations like Beijing TV and Radio stations.

LANE ROBOT SYSTEM

In Shenzhen, traffic police are replaced by mobile robots to ease road congestion.

Methodology

(i) Machine – controlled Guard rail that can move to alter the flow of traffic into different lanes.

(ii) **Mono Cameras (Image Sensor) & single Lidar sensor (sensor fusion system)** which let the robot to recognize its left and right side lane along with obstacle detection

(iii) PID controller to control direction of mobile robot.

Purpose

(i)Minimizes the workload on police as it can move between lanes to alter the flow of traffic in less than a minute.

(ii)Reduces the congestion in the morning rush hour.

(iii)Mono camera can detect lane information along with recognizing obstacles information in dynamic environment.

AUTOMATIC EMERGENCY BRAKING (AEB) SYSTEM

This technology helps the driver to prevent the risk of forward collision ahead in a lane by automatically applying the brakes prior to an accident.

Methodology

(i) Collision Warning with Full Auto Brake and Pedestrian Detection (CWAB-PD) – avoid accidents up to 35 km/hour

(ii) This system uses long-range radar and a forward-sensing wide-angle camera to continuously monitor the area in front of the vehicle and camera (CMOS forward looking camera (FLC)) installed behind the windshield to help detect pedestrians.

Purpose

(i) Automatic collision avoidance

(ii) It assists the driver to avoid both rear-end and pedestrian accidents by providing a warning as well as automatic braking using full braking power.

(iii) It is the only system exclusively used in the market to detect avoid accidents with pedestrians.

ADVANCED DRIVER ASSISTANCE SYSTEMS (ADAS)

This technology is a kind of semi and fully autonomous driving used to reduce road fatalities in both passenger and cargo vehicles)

Methodology

Computer Vision (Image Processing) algorithms are used for face and eye (iris) detection (with automotive night vision, Bayesian classification) along with pedestrian detection, road signs recognition ,automated parking and driver fatigue detection.

Purpose

(i) Raises proper alert (Buzzer and LED) automatically if driver is tired (driver drowsiness detection)

(ii)Forward collision warning, automatic emergency brakes, and pedestrian protection system.

(iii) Intelligent speed adaption with cruise control.

CONNECTED CARS (V2V – VEHICLE TO VEHICLE)

It is a technology used in car with embedded sensors and mobile internet connection.

Methodology

Wireless sensor networks and WiMAX accessing system, In – Car connectivity using Ethernet,LTE,RFID, BLE, Zigbee , GPS,Cloud based storage and processing

Purpose

(i) Road Side Assistance – Guidance to the real time traffic, real time weather and safety warning (Can connect with other cars for notifying collision warning)

(ii) Monitors the car for fuel and oil levels, and tracks it in the event of a theft.

UTBC (URBAN TRAFFIC BALANCE CONTROL) MODEL

It is an enhanced network model of urban road traffic networks with a real time signal control system which deals with the balanced distribution of traffic flows in all the road links.

Methodology

(i) **Signal Control Model of Urban Road Traffic Networks** - It was developed based on basic conservation principle of traffic flows by considering three types of road links namely,

a) Source links - provide traffic demand to the investigated road network.
b) Sink links - receives the output from the investigated road network.
c) Internal links which denotes the all internal links.

With these links Discrete-time linear time-invariant control system with the control input being phase green time (i.e. control on the time duration of the green phase of traffic lights) was established.

(ii)**Consensus Feedback Control Law (UTBC Strategy)** - The idea is that the states (feedbacks) of the different signal control system are collected , realized and the asymptotic consensus is reached by which road links of urban traffic networks can reach the balance in distributing the traffic.

Purpose

(i) Prevents Oversaturation (traffic congestion in some road links are high despite of much space in other links) of networks by providing balanced distribution of traffic flows.

(ii) Support intelligent traffic control system for the optimal controlling of the traffic flow at the traffic signal.

(iii) Has improved performance of the traffic network by reducing local congestion in road links.

Simulation tests are conducted in real-world network in Wangjing District in Beijing and this strategy found to be feasible and effective.

ROAD SIDE DETECTION USING LOW COST EMBEDDED PC (RASPBERRY PI 3)

This method proposed an algorithm for a precise roadside detection and tracking by evaluating the changing texture of a road from the centre to the road side.

Methodology

(i) **Logitech C920 USB based 3D Projection cameras** (act as vision sensor with input and output control) are mounted on the dashboard and from its intrinsic parameters Region Of Interest (ROI) of the road appearance are evaluated and defined ,

(ii) **Hough transform Opencv** are used to detect similar straight lines (after edge detection) in ROI.

(iii)**Nearest-Neighbor interpolation Texture filtering** method is applied on the horizontal line of the projected specified road distance of ROI and textual disparity is evaluated in the pixels and finally texture filtering are used to mark the edge between the road and road side area. Road side detection are estimated based on the vanishing points on the projected distance

(iv) **Raspberry pi** used as embedded PC fixed at the centre of dashboard to detect road ahead process the input received from the camera

Purpose

(i) Used in road side detection and real time tracking of Autonomous car.

(ii)Yields faster Road edge localization and detection

(iii) Used both as road map modelling and driver assistance system.

VARIABLE MESSAGE SIGNS (VMS)

It is a leading travel control real- time devices of dynamic traffic management systems mostly placed in places like highways, major road junctions and urban arteries.

Methodology

These signs (can be a message, pictograms) are installed at the side or above the roadway which uses text and graphics in monochrome or color.

(i) **LED VMS** are deployed in all sorts of traffic environments which utilizes groups of solid-state diodes which forms a single pixel. Based on applied voltage, each pixel group are formed into characters or pattern of the displayed message.

(ii)**Flip - Disk Display** – These are dot matrix display technology which uses a system of small circular, square, or rectangular disks, which individually rotate or flip to form characters on the VMS.

(iii) **Fiber Optic -** Fiber Optic strands are used to strung between each pixel and a lamp source which are powered to several pixels. The messages (characters or pattern) are displayed by the magnetic control of the strands.

(iv) **LCD VMS** – These are mostly used for parking guidance systems and information displays despite full sunlight or complete darkness.

Purpose

(i) It assist the motorist or driver about en- route traveller information like emergencies (about collisions) , construction notices ,maintenance operations schedule ,weather conditions, congestion conditions ahead and so on to ensure traveller's safety.

(ii) It let the traveller's sign that limit the speed and also can be altered depending on weather or traffic conditions or both

(iii) It gives parking sign showing if there are available spaces in a car parking lot.

(iv) It can be integrated with other traffic control and management systems for providing data for traffic detection, monitoring and surveillance.

VANET BASED SAFETY AND ROUTE PLANNING METHOD

This is a prominent method which provides various applications using VANETs (Vehicular Ad hoc Networks) such as route discovery for alleviating traffic congestion, emergency and road clogging warning to the moving motors (i.e smart vehicle with sensors and actuators)

Methodology

VANET technology is sub part of MANET (Mobile Ad hoc Network) where moving vehicles (running at different speed) are considered as wireless nodes which forms a network of vehicles that enables moving automobiles (approximately 100-300 meters apart) to communicate among themselves for improving security in the road.

(i) **On – Board Unit (OBU) & Road Side Unit (RSU)-** Vehicles are equipped with devices like GPS(DGPS) module, Wireless communication module (UMTS, IEEE 802.11p, Bluetooth, Zigbee, etc.,) and Sensor module (Radar, LIDAR) connected to the CCM (Central Control Module) which has data transceiver (DSRC- Dedicated Short Range Communication module) with PCI bus and Ethernet port ,memory unit (DDR -SDRAM, Flash), control unit and information processing unit (microprocessor) for judging and decision making.

(ii) **Human - Machine interface module LCD and Cameras** – It performs displaying function (i.e., receiving messages and warning (e.g. rear end collision) messages are displayed on the LCD screen).

(iii) **Linux kernel** – Supply complete support for the network like drivers for devices like serial port, PCI, and LCD, etc. and the API for the users.

(iv) **Broadcasting and Mobicasting** (time constrained) algorithms

Purpose

(i) Improved Road Safety providing optimal scheduling of traffic flow and traffic light by in - auto sensors and processing technologies.

(ii) Complete driver support system (Co-operative driving) by auto - interpretation of real time information (distributing information about obstacles and hazards) and adjusting speed with reduced fuel consumption and gas emission.

(iii) Enhanced and optimized route guidance (Proactive and Reactive routing) and ensure comfort and infotainment by providing the driver with information support and entertainment to make their journey more amiable (convenience oriented).

(iv) Alert the vehicles with best QoS with collision warning (post – crash), traffic warning lane change assistance, circumvent distraction of the driver by alarm sound and auto brake system.

(v) Reliable emergency service like search and rescue operations (by sending the information to the nearest hospitals and police stations) and disaster recovery.

DECISION TREE BASED BI-DIRECTIONAL TRAFFIC MANAGEMENT SUPPORT SYSTEM

This model used to construct Intelligent Traffic Management System i.e., Calculating Optimal Route from dynamic status of the road and accurate vehicle identification in case of collision (hit and run) using classification method of Decision Tree .

Methodology

(i) **Computational Models** are a) **Feature extraction** by image and video processing, b) **Classification** are done based on dataset classes of 'types' and 'colors',c) **Search Manager** to store the results and for further filtering based on user's queries in asp.netMVC platform.

(ii) **Decision Tree based vehicle classification (C4.5 algorithm)** – Input data are Surveillance video (high quality CCTV cameras) ,vehicle's characteristics (analysed using GPS and support of IETF - RFC 6455 standards) .Communication servers (Websocket server) to handle the incoming connections to the vehicle and database server (stores the dataset) .Uses divide and conquer technique to categorize input data into classes and C4.5 algorithm is applied on the classes to find the optimal path for destination amidst congestion , collision, heavy rainfall , foggy weather conditions associated with the road.

Purpose

(i) Provides mobility & flexibility for dynamic traffic management

(ii) Gives an ideal decision-making system in traffic distribution on the road network as well as intelligent, integrated and high reliable optimal route estimation for bidirectional traffic scenarios.

(iii)Used for both Real-time Traffic monitoring and Archived events searching (i.e. assist police personnel benefits, such as vehicle identification in event of stolen).

TRAFFIC ACCIDENTS REDUCTION STRATEGY (TARS) FOR VANETS

This is an Intelligent Transportation System (ITS) protocol developed to keep down the number of road accidents and death toll caused by it.

Methodology

In this strategy, the warning messages are transmitted on time as well as assist the driver to take spare route in order to prevent vehicle collisions.

(i) **On-Board Unit (OBU) and Road Side Unit (RSU)** are installed on each vehicle (with GPS) participating in the VANET infrastructure and to have awareness about the road surroundings in order to react to congestion, emergency and so on.

(ii) **Trusted Authority (TA)** - Assigns unique ids to both the RSUs and vehicles.

(iii) **Computational Modules** are - a) Setup phase which describes the process of establishing the VANET, b) Authorization phase which demonstrates the registration process of the smart vehicles with TA, c) Execution phase which broadcasts Basic Safety Message (BSM) at every specified milliseconds which consists of Vehicle – ID, Location, Speed and Direction. Based on latest BSM received from the vehicle, RSU adds (updates) the information about a vehicle and estimate the Safe Distance (SD) i.e distance between the two vehicles moving on the same link. In case if that distance difference is less than the SD, then the RSU of the leading vehicle sends warning message to the succeeding vehicle and at the same time RSU also monitors the Distance and Velocity of each vehicle and sends a warning message to the leading vehicle.

Purpose

(i)Assist forecasting the probability of the occurrence of an accident in advance before it occurs.

(ii) Rerouting traffic to maintain efficient traffic flow ant to prevent traffic jams on the road that may cause accidents

(iii) Aid drivers to reach a destination on time by reducing the delay in finding the alternate path.

(iv) Holistic approach which yields better performance in message delivery ratio, message loss ratio with minimized delay.

RFID BASED TRAFFIC CONGESTION ESTIMATION

It is a method of RFID (Radio Frequency Identification) wireless communication reader which transfer necessary information to a database in a Central Computer System (CCS) which estimates the traffic congestion status of the road network.

Methodology

(i) RFID Technology - Uses electromagnetic waves for automatic identification, reading (with reader antenna which broadcast the radio waves, receives and decodes the response from tags of vehicles) and tracking of tags attached to the registered vehicles with help of RFID middleware (responsible for managing, monitoring and configuring the different RFID readers.

(ii) **Central Computer System (with GSM)** -After the vehicle tag information is read and it is sent immediately to the CCS unit which performs real-time monitoring ,management of vehicle movement conditions , maintenance on the communication with the readers and displays the warning status of traffic jam in the road.

(iii) **WiMAX & Ethernet** – Enables the communication between CCS and readers.

Purpose

(i) Displays the warning status in the form of classified level of three patterns of congestion (Red – traffic jam, Yellow – slow moving and Green – free flow).

(ii) Can be applied for Automatic vehicle identification, Electronic Toll Collection (ETC), Smart Parking, and Congestion zone pricing.

(iii) Accurate tracking and real-time updates of vehicles check in/check out with reduced theft, minimized cost and improved safety & security.

DYNAMIC TRAFFIC MANAGEMENT SYSTEM USING INTERNET OF THINGS (IOT)

This system make use of IR sensors and IoT based communication (Raspberry pi) for efficient automated traffic management.

Methodology

(i) **Infra-Red (IR) Sensors** – Mounted on the vehicle which senses the approaching hurdles / obstacles in its way and let the user with traffic-density out of it .

(ii) **Wi-Fi Transmitter interfaced with Raspberry pi** - The sensed data collected from IR sensor are transmitted by the Wi-Fi transmitter which is received by Raspberry-pi processor (as a central console) where the information is processed and inferences (analysis results) are stored in the cloud which intimates the traffic status through API in user's mobile device.

Purpose

(i) Assist onsite traffic police officer to control emergency situations.

(ii) Enhanced information transmission, traffic monitoring and management via. IoT using cost effective Raspberry pi devices.

(iii) Connecting devices in transportation directly to the cloud servers gives more accurate and dynamic real-time distribution of traffic density.

COMPUTER VISION BASED VEHICLE DETECTION AND COUNTING SYSTEM

This system provides an intelligent traffic management system by using video based (analysis and interpretation of images on the videos captured by a digital camera) method for accurate detecting the moving vehicles.

Methodology

(i) **Video Motion Analysis** – Estimate the speed of vehicles in the video and uses background subtraction technique which detect pixels of a moving vehicles. Background image of the road, which contains no vehicle so the frame in that video are converted from RGB color image to gray-scale image by thresholding operation (separate foreground pixels from background pixels based on their intensity)

(ii) **Image segmentation** – Partitions images into multiple sets of views and vehicle detection is done by considering only the pixels in the ROI (Region of Interest).

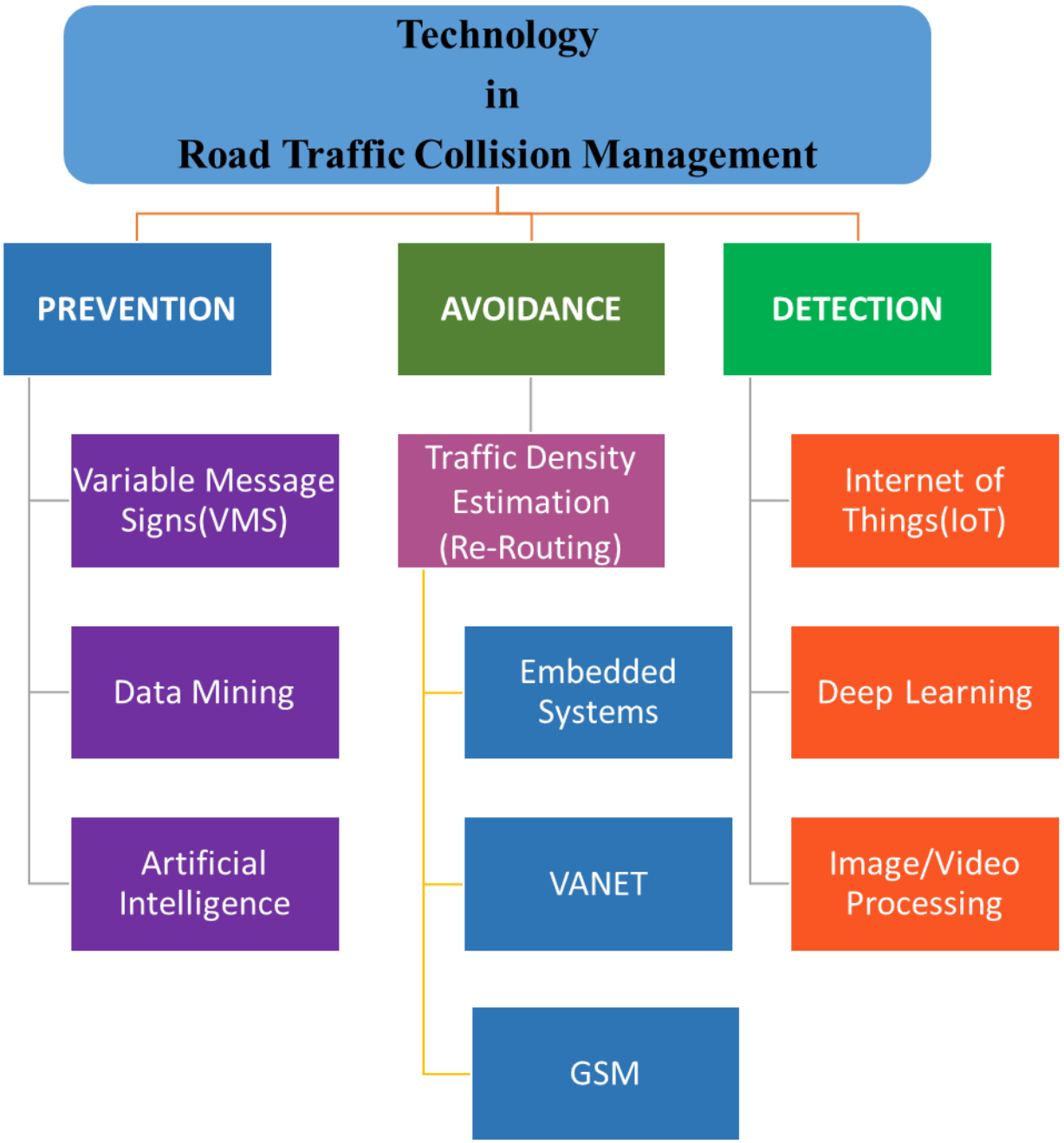
(iii) **Vehicle Counting** - After vehicle shapes are obtained, the virtual detection zone are defined and then their positions are tracked by setting its status to 1 (counted) and indicating that it has been counted

Purpose

(i) Video sequence of road are processed and analysed (speed of a vehicle and traffic density) to estimate detect and count vehicles that are moving on the lanes of a road or a motorway by using a detector virtually located on the road.

(ii) Enables frame by frame segmentation tracking for traffic monitoring such as vehicles trajectories surveillance and counting the vehicles that stop at a junction and detection of events such as a vehicle stops on a road or a possible accident.

(iii) It also predict dangerous situations (accidents, vehicles that go off the road and so on) that trigger an automatic warning to the vehicles.



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