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SMART ADAPTIVE TRAFFIC CONTROL

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Abstract: Traffic is a major crisis in many metropolitan cities. Many people suffer because of the traffic signals. Few considerations are: People rushing to their workplace but can't make it on time due to uncontrolled traffic issues; An emergency service such as Ambulances, Police vehicles, Fire Engines etc. which gets caught in heavy traffic and can't move because of the chaotic traffic problems. Waiting in a signal when there is no traffic in the other lanes is a loss of one's precious time. Every second matters for people who need it the most. Traffic signals run on a Timer based system in which each lane is given a set of seconds to move. In order to make a more efficient system of traffic system, we introduce the "Smart Adaptive Traffic Control". The Smart Adaptive Traffic Control is an automated traffic governing system which detects the traffic in both lanes and thereby compares the traffic density and gives the Green signal on the basis of priority and also sets a time duration in accordance with the traffic density i.e. More the traffic density, more will be duration to clear the traffic in that lane. Less the traffic density, lesser will be the duration to clear the traffic. This is implemented using a raspberry pi for processing and camera is used for image acquisition and traffic signal is triggered using GPIO of raspberry pi.

I. INTRODUCTION

This system proves to be quite more efficient that the existing system as it ensures less time is being wasted for less dense lanes and concentrates on the more dense lanes. This thereby controls people from wanting to violate traffic rules and regulations in order to meet their time schedules. This system replaces the existing system by detecting the density of traffic using camera instead of using sensors or by manual intervention. The existing system uses a microcontroller which works on timing basis which is major drawback in existing system at high traffic. Traffic is becoming a major problem in modern cities. Our major idea is to produce an advance technology which can reduce the hectic traffic in today's cities. Today time has become an important factor in every one life. Instead of waiting in a signal for long time our proposed model is independent of time respective of the traffic movement. The existing traffic signals doesn't change the signal timing based on the density of traffic which lead to heavy traffic in one area and the area with less traffic is in green signal this leads to lot of consumption of time. This model consumes lot of time for the commuters to wait in the traffic signal for long time even though there is no traffic in that particular signal. The existing system works based on the density of the traffic and depending on the density of the traffic the traffic light is controlled. This saves a lot of time in waiting in traffic signal. This system detects the density of multiple lanes and signalling each system with single controller, hence making more efficient use of power and resources. This system works more effectively during peak hours in metropolitan cities where there is traffic only due to the light vehicles.

II. RELATED WORK

Literature Survey on Density Based Signal Management by Shweta N. Pable, Amit Welekar

In this system the traffic signal works with the help of microcontroller and the signal woks based on the timing. The propose system is the Traffic Density Based Signal Management in Traffic System which deal with traffic load in each side of lane during high density traffic on road at specific time. Here we are considering the main scenario at time when the traffic is extended for, less no. of vehicles then signal activate for less number of time. If the traffic gets on increasing on other side of lane then, the problem with previous algorithm is that, the vehicles on other side those arrived first as compared to others have to wait. In previous they introduce equal size platoon. We are proposing such a system that deal with such kind of problem by automatically switching the signal by calculating the time at which the vehicles arrived at stop line. We first formulate the vehicular traffic signal control problem as a job scheduling problem on processors. In our system we switch the signal if the density of vehicle is high then the maximum time is allocated. In our system we are not decide the platoon length or size. Our system show result under light medium & heavy traffic. . This makes waiting in traffic signal even though there is no traffic.

Density Based Traffic Signal System by K.Vidhya, A.Bazila Banu

The project is designed to develop a density based dynamic traffic signal system. The signal timing changes automatically on sensing the traffic density at the junction. Traffic congestion is a severe problem in many major cities across the world and it has become a nightmare for the commuters in these cities. Conventional traffic light system is based on fixed time concept allotted to each side of the junction which cannot be varied as per varying traffic density. Junction timings allotted are fixed. Sometimes higher traffic density at one side of the junction demands longer green time as compared to standard allotted time. The image captured in the traffic signal is processed and converted into grayscale image then its threshold is calculated based on which the contour has been drawn in order to calculate the number of vehicles present in the image. After calculating the number of vehicles we will came to know in which side the density is high based on which signals will be allotted for a particular side. Raspberry pi is used as a microcontroller which provides the signal

timing based on the traffic density.
The problem in this system is that it takes more time for processing the image as it uses many operations on the image such as edge detection of the image and creating erode image. After these operations are completed, the number of vehicles are found which makes more time.

Automatic Traffic Estimation Using Image Processing by Pejman Niksaz
As we know the population of city and number of cars is increasing day by day. With increasing urban population and hence the number of cars, need of controlling streets, highways and roads is vital. In this paper, a system that estimates the size of traffic in highways by using image processing has been proposed and as a result a message is shown to inform the number of cars in highway. This project has been implemented by using the Matlab software and it aims to prevent heavy traffic in highways. Moreover, for implementing this project following steps must be considered: 1) image acquisition 2) RGB to grayscale transformation 3) image enhancement and 4) morphological operations. At first, film of highway is captured by a camera has been installed in highway. Then, the film comes in the form of consecutive frames and each frame is compared with the first frame. After that, the number of cars in highways is specified. At the end, if the number of cars is more than a threshold, a message is shown to inform the traffic status. By this message we can predict the need to reduce the size of traffic carried. Experiments show that the algorithm will work properly. This system detects the density of the traffic using image processing with the help of matlab and arduino and changes the traffic signal depending upon the traffic the signal changes.The disadvantage with is system is matlab requires takes more time for processing each image and requires more memory and processing speed for each instruction.

VEHICLE DENSITY SENSOR SYSTEM TO MANAGE TRAFFIC by Ashwini Basavaraju, Senhalata Doddigarla, Navitha Naidu , Shruti Malgatti
The aim of this study is to solve traffic congestion which is a severe problem in many modern cities all over the world. To solve this problem, we have a framework for a dynamic and automatic traffic light control system. Generally, each traffic light on an intersection is assigned a constant green signal time. It is possible to propose a dynamic time-based coordination schemes where the green signal time of the traffic lights is assigned based on the present conditions of the traffic. In this study, we adapt the approach to take data/input/image from object/ subject/vehicle and to process the input data by Computer and Microcontroller and finally display it on the traffic light signal to control the Closed Loop System. There is a wide range of sensor technologies available for vehicle detection. Some common and developing technologies are listed and one of the flexible types of sensors (IR sensor) used is explained in this paper. The problem with this method is it is costlier to implement more IR sensors in large scale for traffic signalling.

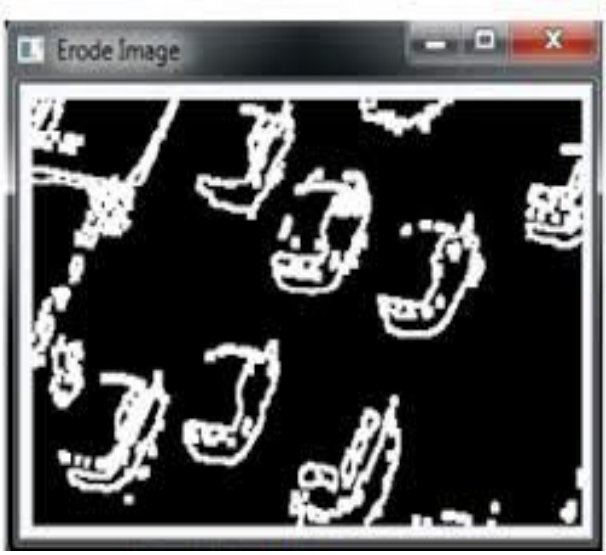
III. METHODOLOGY

IMAGE ACQUISATION AND PROCESSING
The basic requirement for any image to be processed is it should be acquired from a camera without any noise. The image is stored in any specific format which is suitable for processing. Then the image is processed according to the application.
The image is stored in JPEG format in the database and retried using system coding which is written in embedded c. The image containing the data about the traffic is processed using a suitable algorithm.

TRAFFIC DENSITY DETECTION:
There are different techniques through which the density in the traffic is found. The traffic is found either as an overall average count or by founding the boundary. In this project we have counted the number of vehicles in each lane. As the presence of each vehicle is found, each vehicle is highlighted by a rectangular box. The total number of boxes gives the number of vehicles in the lane. This total number of cars is found as an approximate result.

VEHICLE DETECTION TECHNIQUE:
The vehicle detection technique is based on object detection methods. The objects are detected on two basis.One is by their appearance and another one is by their features. There are various methods used for counting the vehicle by their appearances.
The different methods and techniques are given below:
Canny Edge detection method
Divide and conquer search
Thresholding and Linking
Edge Thinning

CANNY EDGE DETECTION:
Canny edge detection is a technique to extract useful structural information from different vision objects and dramatically reduce the amount of data to be processed. It has been widely applied in various computer vision systems. Canny has found that the requirements for the application of edge detection on diverse vision systems are relatively similar. Thus, an edge detection solution to address these requirements can be implemented in a wide range of situations. The general criteria for edge detection include:
Detection of edge with low error rate, which means that the detection should accurately catch as many edges shown in the image as possible
The edge point detected from the operator should accurately localize on the centre of the edge.
A given edge in the image should only be marked once, and where possible, image noise should not create false edges.
To satisfy these requirements Canny used the calculus of variations – a technique which finds the ((function which optimizes a given ((functional. The optimal function in Canny's detector is described by the sum of four exponential terms, but it can be approximated by the first derivative of a Gaussian.



DIVIDE AND CONQUER SEARCH

Strategy:

Consider all positions as a set (a cell in the space of positions).

Determine lower bound on score at best position in cell.

If bound is too large, prune cell.

If bound is not too large, divide cell into sub cells and try each sub cell recursively.

Process stops when cell is "small enough".

Finding the Bound:

To find the lower bound on the best score, look at score for the template position represented by the center of the cell.

Subtract maximum change from the "center" position for any other position in cell (occurs at cell corners).

Complexities arise from determining bounds on distance.

GREYSCALE MATCHING

Edges are robust to illumination changes, however they throw away a lot of information.

Must compute pixel distance as a function of both pixel position and pixel intensity.

Can be applied to colour also.

GRADIENT MATCHING

Another way to be robust to illumination changes without throwing away as much information is to compare image gradients.

Matching is performed like matching greyscale images.

Simple alternative: Use normalized correlation.

OBJECT DETECTION USING FEATURE EXTRACTION

This method of object detection uses special characteristics of object and various methods of finding the object are

Interpretation tree

Pose Clustering

Artificial Neural Network

Haar cascade classifiers

INTERPRETATION TREE

A method for searching for feasible matches is to search through a tree.Each node in the tree represents a set of matches.Root node represents empty set.

Each other node is the union of the matches in the parent node and one additional match.

Wildcard is used for features with no match.

Nodes are "pruned" when the set of matches is infeasible.

A pruned node has no children.

Historically significant and still used, but less commonly.

POSE CLUSTERING

Each object leads to many correct sets of correspondences, each of which has (roughly) the same pose.

Vote on pose. Use an accumulator array that represents pose space for each object.

This is essentially a Hough transform.

For each object, set up an accumulator array that represents pose space – each element in the accumulator array corresponds to a "bucket" in pose space.

Then take each image frame group, and hypothesize a correspondence between it and every frame group on every object.

For each of these correspondences, determine pose parameters and make an entry in the accumulator array for the current object at the pose value.

If there are large numbers of votes in any object's accumulator array, this can be interpreted as evidence for the presence of that object at that pose.

The evidence can be checked using a verification method.

Note that this method uses sets of correspondences, rather than individual correspondences.

Implementation is easier, since each set yields a small number of possible object poses.

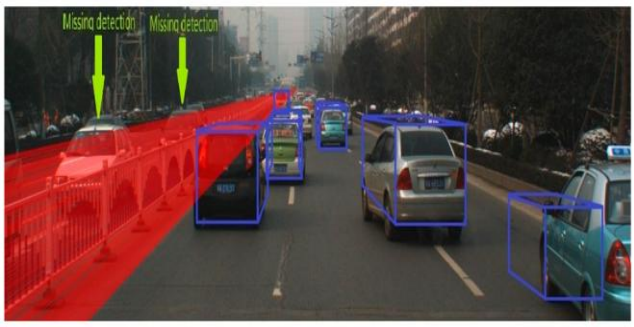
The noise resistance of this method can be improved by not counting votes for objects at poses where the vote is obviously unreliable.

ARTIFICIAL NEURAL NETWORK

Artificial neural networks (ANNs) or connectionist systems are a computational model used in computer science and other research disciplines, which is based on a large collection of simple neural units (artificial neurons), loosely analogous to the observed behavior of a biological brain's axons. Each neural unit is connected with many others, and links can enhance or inhibit the activation state of adjoining neural units. Each individual neural unit computes using summation function. There may be a threshold function or limiting function on each connection and on the unit itself, such that the signal must surpass the limit before propagating to other neurons. These systems are self-learning and trained, rather than explicitly programmed, and excel in areas where the solution or ((feature detection is difficult to express in a traditional computer program. Neural networks typically consist of multiple layers or a cube design, and the signal path traverses from the first (input), to the last (output) layer of neural units. Back propagation is the use of forward stimulation to reset weights on the "front" neural units and this is sometimes done in combination with training where the correct result is known. More modern networks are a bit more free flowing in terms of stimulation and inhibition with connections interacting in a much more chaotic and complex fashion. Dynamic neural networks are the most advanced, in that they dynamically can, based on rules, form new connections and even new neural units while disabling others.

HAAR CASCADE CLASSIFIERS

Haar-like features are digital image ((features used in object recognition. They owe their name to their intuitive similarity with Haar wavelets and were used in the first real-time face detector. Working with only image intensities (i.e., the RGB pixel values at each and every pixel of image) made the task of feature calculation computationally expensive. Working with an alternate feature set based on Haar wavelets instead of the usual image intensities. Viola and Jones adapted the idea of using Haar wavelets and developed the so-called Haar-like features. A Haar-like feature considers adjacent rectangular regions at a specific location in a detection window, sums up the pixel intensities in each region and calculates the difference between these sums. This difference is then used to categorize subsections of an image. For example, let us say we have an image database with human faces. It is a common observation that among all faces the region of the eyes is darker than the region of the cheeks. Therefore a common haar feature for face detection is a set of two adjacent rectangles that lie above the eye and the cheek region. The position of these rectangles is defined relative to a detection window that acts like a bounding box to the target object. A simple rectangular Haar-like feature can be defined as the difference of the sum of pixels of areas inside the rectangle, which can be at any position and scale within the original image. This modified feature set is called 2-rectangle feature. Viola and Jones also defined 3-rectangle features and 4-rectangle features. The values indicate certain characteristics of a particular area of the image. Each feature type can indicate the existence (or absence) of certain characteristics in the image, such as edges or changes in texture. For example, a 2-rectangle feature can indicate where the border lies between a dark region and a light region.



In this project we have used haar cascade classifiers to detect the vehicle count. This is stored as a XML file in database. The algorithm consist of coordinate points which specifies the features of the object. The object used here is car or vehicle where algorithm detects the coordinate points of windshield. By detecting the windshield the algorithm creates a 2D rectangular box over the car.

General web image page not always contain the name of celebrity in an image. Because of noise in web data it becomes difficult to identify celebrity name form web page text. There are mainly two challenges. Firstly the surround text of web image is lacking of standard grammar structure, therefore it is difficult to apply natural language processing techniques to extract celebrity names from it. Secondly the celebrities face in image may be having different pose, makeup, expression and occlusion caused by sunglasses or fancy hairstyles. So it becomes difficult to identify celebrity in an image with visual analysis and a normal face database.

An algorithm could belong to two or more categories. This classification can be made as follows:

Knowledge-based methods or Ruled-based methods: that encodes our knowledge of human faces using different rules.

Feature-invariant methods: Algorithms that try to find invariant features of a face despite its angle or position.

Template matching methods: These algorithms compare input images with stored patterns of faces or features.

Appearance-based methods: A template matching method whose pattern database is learnt from a set of training images. Let us examine them in detail.

A. Knowledge - Based Methods:

These are rule-based methods. They are based on our knowledge of faces, and translate them into a set of rules. It's easy to guess some simple rules. For example, a face usually has two symmetric eyes, and the eye area is darker than the cheeks. Nose is at the centre of face. Mouth is at the bottom of face area. The big problem with these methods is that it is difficult to form appropriate set of rules. There could be high false positives rate if the rules were too general. On the other hand, there could be high false negatives rate if the rules were too detailed. A solution is to build hierarchical knowledge-based methods to overcome these problems. However, this approach alone is very limited. It's unable to find many faces in a complex image.

B. Feature-Invariant Methods:

To overcome the limitations knowledge based methods for face detection. Feature-invariant methods are introduced. The method is divided in several steps. Firstly, it tries to find eye-analogue pixels, so it removes unwanted pixels from the image. After performing the segmentation process, they consider each eye-analogue segment as a candidate of one of the eyes. Then, a set of rule is executed to determinate the potential pair of eyes. Once the eyes are selected, the algorithm calculates the face area as a rectangle.

C. Template Matching Methods:

These methods define a face as a function. We try to find a standard template of all the faces. Two templates are discussed here. First, a face can be divided into eyes, face contour, nose and mouth. Also a face model can be built by edges. But these methods are limited to faces that are frontal and unclouded. Other templates use the relation between face regions in terms of brightness and darkness. These standard patterns are compared to the input images to detect faces. This approach is simple to implement, but it's inadequate for face detection. It cannot achieve good results with variations in pose, scale and shape.

D. Appearance-based method:

The templates in Appearance-based methods are learned from the examples in the images. In general, appearance based methods rely on techniques from statistical analysis

and machine learning to find the relevant characteristics of face images. Some appearance-based methods work in a probabilistic network. An image or feature vector is a random variable with some probability of belonging to a face or not.

Training Classifiers for Facial Features:

HAAR Classifier needs to train to detect human facial features, Such as the mouth, eyes, and nose. To train the classifiers, AdaBoost algorithm and HAAR feature algorithms must be implemented. Intel developed an open source library devoted to easing the implementation of computer vision related programs called Open Computer Vision Library (OpenCV). To train the classifiers, two set of images are needed that are negative image set and positive image set. Negative image set contains an image or scene that does not contain the object, in our case a facial feature, which is going to be detected. The other set of images, the positive images, contain objects that are facial features. The location of the objects within the positive images is specified by: image name, the upper left pixel and the height, and width of the object. For training facial features 5,000 negative images with at least a mega-pixel resolution were used. These images consisted of everyday objects, like paperclips, and of natural scenery, like photographs of forests and mountains but not the face image. For more accurate facial feature detection, the original positive set of images is needed which include large variation between different people, including, race, gender, and age. Three separate classifiers were trained, one for the eyes, one for the nose, and one for the mouth. Once the classifiers were trained, they were used to detect the facial features within another set of images in database.

Regionalized Detection:

A method is needed to reduce the false positive rate of the classifier and to increase accuracy, without modifying the classifier training attribute. The proposed method is to limit the region of the image that is analysed for the facial features. For example region analysis for mouth is limited to bottom area of face, for nose it is limited to centre area of face and for eyes it is limited to upper area of face. By reducing the area analyzed, accuracy will increase since less area exists to produce false positives. It also increases efficiency since fewer features need to be computed and the area of the integral images is smaller.

IV. RESULTS AND DISCUSSION

DEVELOPMENT OF THE PROJECT

The Smart Adaptive Traffic Controller has its own uniqueness and provides a stable concept for regulating traffic flow in most of the metropolitan cities. reasons for the development of this system are

Response time
Unique Algorithm
Feasibility
Low Power consumption
Automatic Intelligence
Flexibility

RESPONSE TIME

Our project claims to primarily have a very fast processing speed. The captured video is processed efficiently and gives an accurate output within 2 seconds. This way the traffic system becomes more efficient for the very less processing time/ Response time.

UNIQUE ALGORITHM

The Haar-Cascade algorithm which is used in our system for video processing purpose is a very unique one and this plays a vital role in reducing the response time; which is the time taken for the whole process to complete. Time plays a vital role in traffic and is our pivot reason for developing this project. This way we can ensure the most efficient usage of traffic signals.

FEASIBILTY

Our project comprises of an external video camera and the raspberry Pi2 processor. This way our system is very feasible. By attaching this system to the traffic control system, it does not cause any time delay and difficulties for setting up our system. This way we ensure we do not reimburse any fixation cost or totally change the current system. In short, it is just an addition to the existing system.

LOW POWER CONSUMPTION

In our project, we ensure that the power consumption is very less as we are using very less hardware components for the whole model. The 5V power supply is the necessity to keep the system running. So high power efficiency is ensured this way.

AUTOMATIC INTELLIGENT

Our system is an automated system and does not require any manual or master control console. The traffic light changes automatically based on the density of the traffic (Number of Vehicles) which is a first of its kind as no other model was developed similar to this and also uses computer vision for sensing the traffic issues in the focused lanes.

FLEXIBLITY

Our project is very flexible to set up in roads. It can be implemented for all 2 crossroads, 3 crossroads and 4 crossroads using a single camera, which further reduces the production cost. As our camera is fixed on a motor, we can mention desired degree to which it has to rotate. For ex, 1800 for 2 crossroads and 900 for 4 crossroads. So we reduce costs and increase the purpose of the system.

V. CONCLUSION AND FUTURE WORK

Hence this system provides an automated signal control without any human intervention on the signal and saves more time which reduces the waiting time at traffic signal. This system can detect traffic at any weather provided that at least minimum light requirement should be needed. Moreover this system provides computer vision at reduced cost and consumes low power. This system will be more useful in metropolitan cities where the traffic has to be regulated automatically and can be implemented in places where the traffic has to be regulated in an intellectual way. This System has an advantage of being mobile and has an ability to be modified according to the usage. This system will overcome the disadvantage of existing system in efficient way in all aspects.

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