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Vehicle classification and analyzing motion features

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ABSTRACT

This system can detect, recognize, track multiple vehicles and provide the information on the object vehicles. Image processing technology is employed in the object detection. Once the potential objects are detected, related information will be calculated and used to judge if the object vehicle is hazardous to the host vehicle and it is useful in parking lots and in the traffic signal.

Keywords: Vehicle Detection, Tracking, Motion Analysis

1. INTRODUCTION

This research work focuses in applying image processing concepts for detecting and tracking vehicles. Videos collected from different conditions in which vehicles were moving are used for analysis. Videos have been used as it is non-intrusive process and can be analyzed offline.

Vehicle should follow traffic rules and move inside a lane for implementing the proposed algorithms. If the vehicle is moving inside lane, false rejection of an actual vehicle or false identification of an object which is not a vehicle can be minimized. The following steps show how to identify a vehicle and direction in which vehicle is moving.

Step 1: Identify if it is a vehicle. Discard other objects.
Step 2: Verify if the vehicle is moving.
Step 3: For each vehicle identified in a frame, a vector consisting of {width, height, segmented object, average intensity value, road brightness (dark/light/bright)} is created. This step is required for tracking the vehicle in the subsequent frames.
Step 4: Find the change in the vehicle size, and the direction of vehicle can be obtained. If the vehicle size grows, it indicates that the vehicle is coming towards the camera.

The next position of vehicle-1 to vehicle-N are obtained in the frames (n+1)s by finding the x,y locations of the vehicles-1 to N as mentioned below:

$$V_1(n+1)_{x,y} - V_1(n)_{x,y}$$
$$V_2(n+1)_{x,y} - V_2(n)_{x,y}$$
$$\vdots$$
$$V_N(n+1)_{x,y} - V_N(n)_{x,y}$$

A vehicle can miss in some of the frames due to the following:

1. Overlap with other vehicles inline.
2. Has taken a left or right turn.

2. PROBLEM DEFINITION

There is an increase in traffic flow due to development of vehicle technologies and transport systems. Improved monitoring techniques are evolved to make sure that vehicles are detected and tracked in all weather conditions. Detecting the movement of the vehicle in video sequence is difficult because of illumination condition, background images, and occlusion, unexpected object motion, change in form of the object pattern, non-rigid structures of object. The problem is to evolve new techniques to

1) Improve vehicle identification.
2) Track continuously in the subsequent frames of video.

Vehicle tracking is implemented using non-intrusive technology such as ultrasonic, microwave and image processing. Image processing is used to detect vehicles by analyzing the images in the successive frames taken from a traffic scene. The change between successive frames helps in identifying the presence of vehicle. The black and white images are examined. The variation of gray levels in groups of pixels contained in the video frames is considered. The algorithms are designed to remove gray level variations in the image background caused by weather conditions, shadows, and daytime or nighttime artifacts and retain objects identified as automobiles, trucks, motorcycles, and bicycles. Traffic flow parameters are calculated by analyzing successive video frames. Color imagery can also be exploited to obtain traffic flow data. However, somewhat reduced dynamic range and sensitivity have so far inhibited this approach.

Three categories of vehicle detectionis adopted in videos.

1. **Tripline:** Tripline systems operate by allowing the user to define a limited number of detection zones in the field of view of the video camera. When a vehicle crosses one of these zones, it is identified by noting changes in the pixels caused by the vehicle relative to the roadway in the absence of a vehicle. Surface-based and grid-based analyses are utilized to detect vehicles in tripline video image processing (VIP)s. The surface-based approach identifies edge features, while the grid based classifies squares on a fixed grid as containing moving vehicles, stopped vehicles, or no vehicles. Tripline systems estimate vehicle speed by measuring the time it takes an identified vehicle to travel a detection zone of known length. The speed is found as the length divided by the travel time.
2. **Closed-loop tracking:** It is an extension of the tripline approach that permits vehicle detection along larger roadway sections. The closed-loop systems track vehicles continuously through the field of view of the camera. Multiple detections of the vehicle along a track are used to validate the detection. Once validated, the vehicle is counted and its speed is updated by the tracking algorithm. These tracking systems may provide additional traffic flow data such as lane-to-lane vehicle movements. Therefore, they have the potential to transmit information to roadside displays and radios to alert drivers to erratic behavior that can lead to an incident.
3. **Data association tracking:** Data association tracking systems identify and track a particular vehicle or groups of vehicles as they pass through the field of view of the camera. The computer identifies vehicles by searching for unique connected areas of pixels. These areas are then tracked from frame-to-frame to produce tracking data for the selected vehicle or vehicle groups. The markers that identify the objects are based on gradients and morphology. Gradient markers utilize edges, while morphological markers utilize combinations of features and sizes that are recognized as belonging to known vehicles or groups of vehicles.

3. DATA COLLECTION

Video database has been created by shooting video in hand DIGICAM. The videos are transferred to laptop. OSS decompiler has been used to extract the frames of the video. The video has been taken in the day time, cloudy time, late evening and at night. All the information are processed using MATLAB R2011a. It is a high-level language and interactive environment for numerical computation, visualization, and programming. Using MATLAB we can get the solution faster than traditional programming languages. The following frames show distinctly the road, track lines and vehicles when viewed inclined, straight and curved. Figure 3.1 presents sample frames of video taken by fixing camera in a car.

Figure 1 Sample frames

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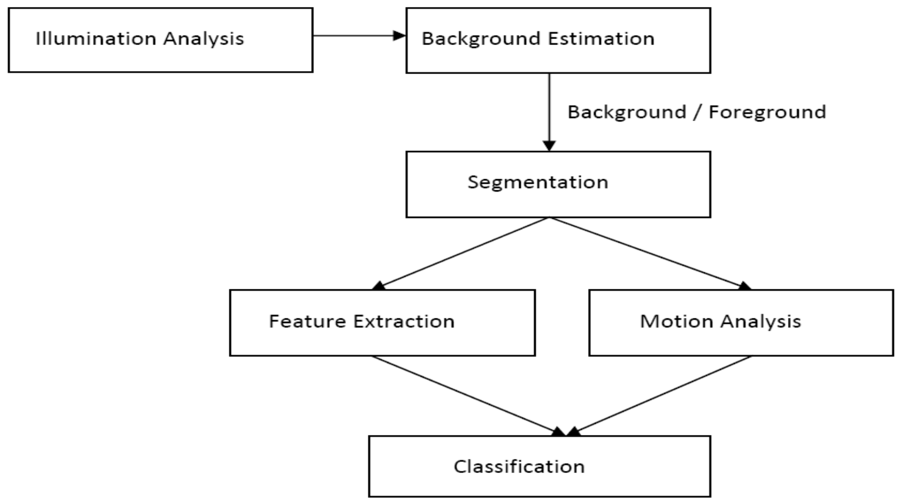

Figure 2 Classification by proposed algorithms

4. PROCEDURE FOR OBJECT CLASSIFICATION

In the Figure 3.2 shown, each single rigid and moving/static object is tracked. Each object is enclosed with rectangle, with the following properties: X and Y coordinates of the top left and bottom right of the rectangle, X and Y coordinates of the contour points of the tracked objects. Motion features extracted will be current speed, acceleration value, deceleration value, change in size, change in velocity. The movement of the vehicle is determined based on the previous frames to current frame and are listed as follows: static to static, static to moving, moving to moving, moving to static, sudden stop, sudden speed.

Illumination Analysis: Basic input for this objective is to capture a video sequence of frames. Raw image is captured by the video camera using optical sensors. Determining the perfect illumination is important for the quality of the captured images. Variations in the illumination must be avoided in the image.

Background Estimation: A captured image is preprocessed to reduce the noise in the images. Then the image is enhanced to identify the background difference from the object.

Segmentation: Segmentation is a process that partitions the image into regions. The enhanced image is segmented and used to identify the required object for detection and tracking. The profile of the object (X,Y) with respect to coordinate position of the frame is identified. The points are plotted as a map in the continuous frames.

There are 2 ways for object map: 1) Feature Extraction and 2) Motion Analysis.

Feature Extraction: The features of the object such as shape and the edges of the object are identified.

Motion Analysis: Identify the (X, Y) position of the required object in the first frame. This process is repeated for the remaining frames. By applying affine transformation for the frames given in Figure 3.3, find the change in position of the object in the frame, and hence the movement of the object can be confirmed.

Classification: Object features and the objects position information are given to the classification module.

5. FRAMEWORK OF MOTION ANALYSIS COMPONENT

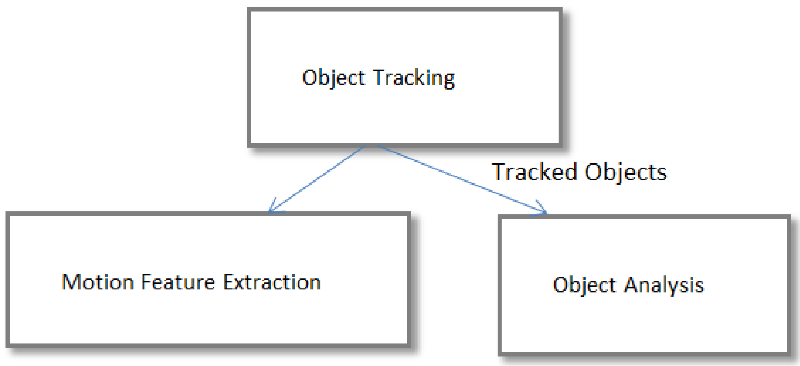

Figure 3 Motion analysis module

Motion analysis component consists of three major modules: Object Tracking, Motion Feature Extraction and Object Analysis. The inputs and outputs of each module and their relationships with other modules are highlighted in Figure 3.3. Three main outputs in the motion analysis component are:

Tracked Object: Each single rigid and moving / static object is tracked and highlighted in different colors. Each object is enclosed with rectangle, with the following properties:

i) X and Y coordinates of the top left and bottom right of the rectangle
ii) X and Y coordinates of the contour points of the tracked objects

Motion Features: The extracted features for each object are listed as follows: Change in size, Current speed, Acceleration value, Deceleration value and Change in Velocity.

Object Status and Label: Types of object status in terms of movement are determined based on the previous frames to current frame and are listed as follows: Static to Static, Static to Moving, Moving to Moving, Moving to Static, Sudden Stop, Sudden Speed.

6. CONCLUSION

This paper has presented sample frames extracted from video. The different parameters that will be calculated is presented. The potential objects are detected, and at the same time, related information such as predicted direction, change in size, change in velocity, ellipse related parameters (major axis, minor axis and angle), static to static, static to moving, moving to moving, moving to static, sudden stop, sudden speed, occlusion with two or more separate objects, split of one object to more than one objects are recognized.

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