THE ALGORITHM OF VEHICLE MONITORING IN CITY BY THE THREE-LINE SCANNER IMAGERY

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1. INTRODUCTION

The Three Line Scanner or TLS Technology has emerged over the last few years. The strong characteristic of Three Line Scanner is to provide the digital image with very ultra spatial resolution of centimeters while, traffic problems in huge cities are more and more severe such as traffic jam, accidents etc. Moreover, as manual vehicle counting, is time-consuming, the automatic method by using image from airborne sensors for road monitoring such as vehicle detection etc. becomes hot and challenging research. With less than 3.5 cm ground resolution and seamless imaging capability along the road, TLS image is much fitted to analyze the traffic problem in the city area of the huge city such as Tokyo, Japan. Moreover, Three Line Scanner consists of Forward, Nadir and Backward images taken simultaneously for direct 3 dimensional object reconstructions. This research mentions novel concepts of road monitoring by Three Line Scanner. The algorithm consists of preparation step and Single and Stereo image processing Algorithm. Preparation provides fundamental information for further Image processing steps. The Single image processing technique has been applied for road as well as Vehicle Detection. The Stereo image processing method is used to investigate the on street parking of Vehicles.

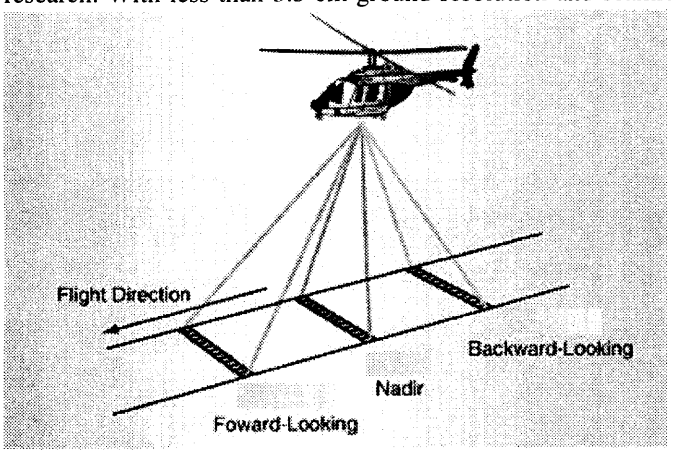

Fig1. Geometry of Three Line Scanner

2. OUTLINE OF THIS STUDY

Because of the many advantages of TLS images mentioned in the chapter 1, the concept of traffic monitoring, especially Vehicles and Their on-street Parking have been developed. Consequently, the strategy of our research has been created as consisting of four conditions:

a) Vehicles processed in our task are only the ones on the main street not the ones in parking lots.
b) Orientation of almost all vehicles is along the road and parallel with the road direction.
c) A vehicle generic component consists of a shadow and rectangular shape. The shadow and Rectangular Shape have unique patterns different from other objects on the road.
d) Only stopping vehicles are generated as 3 Dimensional Vehicles by Stereoscopic Vision.

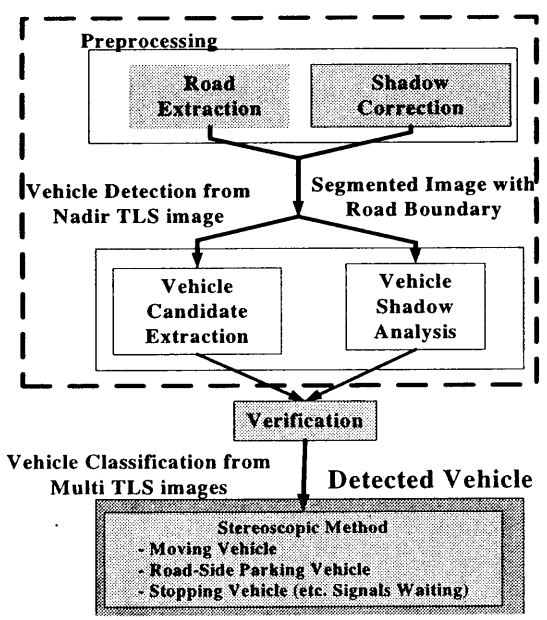

Fig2. Framework of this study

The new idea on our study is fulfilled as the robust algorithm. The framework designed is composed of three key stages of processing: Pre-processing, Single TLS Image Processing and Stereoscopic Image Processing respectively. (See Figure 2) The description is descripted below:

- Pre-processing is the stage of Data preparation consisting of a set of basic image processing techniques such as an image enhancement, including the Region Growing Image Segmentation, Segmented Region Labeling, and Segmented-Region Description with the decision criteria to set Regions of Interest (ROI) for Vehicle Position like Road Surface and Road Direction Calculation by the Radon Transformation of Line Detection.
- Single Image Processing is to discriminate Segmented Regions located in the road and outside the street surface under the Buffering Techniques and the Geometric Property. The next step is to detect vehicle candidates on the street and to verify the vehicle by detecting the vehicle shadow or dark vehicle shapes by the classification under the geometric constraints.
- Stereoscopic Measurement is to discriminate moving and stopping vehicles in the image. Stopping Vehicles can be generated as 3D objects. At present, this stage is being developed and will be realized soon.

Key words: Three-Line Scanner (TLS), Region Growing, Shape Description, Single Image Processing and Stereo Image Processing
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3.VEHICLE DETECTION

Unlike in a frame aerial image, Vehicles that are in TLS image are distorted-varied shapes. However, some generic characteristics are unique. There are three steps: Two steps Geometric Constrain-Vehicle Candidate Detection, Verification Vehicle Shadow/ Dark Vehicle Detection and a step of Relational Constrain.

1.Vehicle Candidate Detection is a method of detecting enclosed regions as Vehicle Candidates by overlaying the road information with the outside-road regions and then subtracting this overlaid information with the segmented region receiving from the pre-processing stage to create the vehicle candidates based on a region-shaped constrains.

2.Vehicle Shadow/ Dark Vehicle Detection: To verify the detected vehicle candidates as real vehicles, some important patterns of vehicle body or their shadow have been defined and examined by finding the shadow based on the shape analysis by extracting the shape of vehicle body or vehicle shadow pattern along the road direction and clustering their statistics of Vehicle or Vehicle Shadow ROI to define the geometric constrains of vehicle shape and vehicle shadow for classifying the shadow and vehicle from the non-vehicle region in the Single Nadir image by the hierarchical decision based on this geometric constraint.

3. Detected Vehicle Candidate Verification: To verify the vehicle in Nadir Single Image, all regions on the road surface are fitted by the flexible-sized rectangle model. The noise or isolated regions are extracted and cleaned by using unique Shape and Gray Scale constrains. Lane Line and other sign regions also are detected with same technique. Finally, the rest of regions on the road are grouped as vehicles based on Relational Constraints.

At a present, first two algorithms of all three stages have been developed and perform in the next charter.

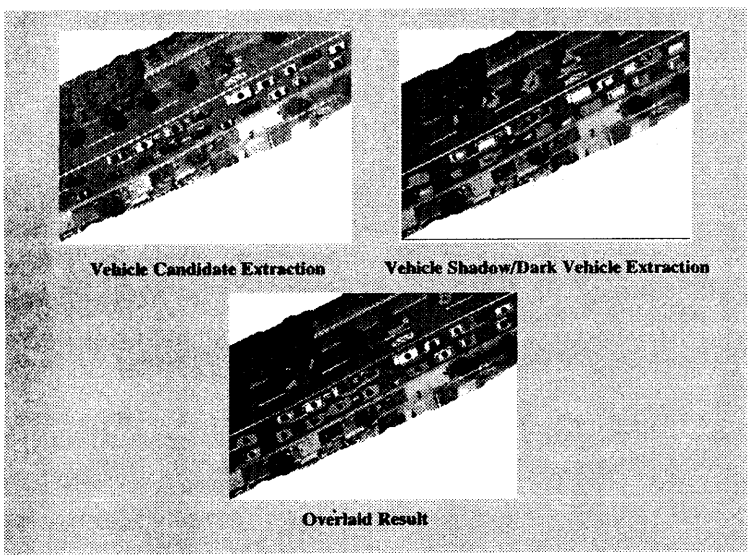

Fig 3 Result of Vehicle Detection by Three Line Scanner Image

4. TEST RESULTS

Our novel Concept that has been crated is developed with Matlab Software Version 6.0.0.88 b Release 12 and based on Nadir, Backward and Forward TLS images taken above Ochanomizu Area, Central Tokyo, Japan with 5 cm resolution. At the first step, the TLS original image is segmented using a region-growing technique by setting initiating parameters selected carefully from a groups of region-growing-testing samples. At a later step, the road surface has been created by the algorithm in a preprocessing step mentioned above. In the TLS Nadir Image Processing, vehicle candidates have been detected and confirmed by identifying their shadow as cue for vehicle, finally

5. CONCLUSION

The now algorithm of a vehicle detection from novel airborne images from Three Line Scanner has been developed with a high rate detection. The achievement is realized principally because of the subsequent aspects of our techniques:

- The algorithm is processed on only Region of Interest defined at the first stage. It is able to avoid the misdetection of the non-vehicle object outside the road surface.
- The road surface direction is the important parameter to determine the vehicle position in the TLS image.
- Unique Patterns of Vehicle Shadow and Shadow are the vehicle detector from the TLS image by the particular statistics of each unique pattern. Also this detector performs the high rate of vehicle detection.

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