Laser Intensity
Automatic Vehicle Classification System

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Introduction

- Automatic vehicle classification (AVC) systems can be used in many applications such as:
  - manual and automatic fare collection processes
  - generating detailed vehicle statistics
  - bridge/tunnel clearance verification

- Current AVC systems that utilize loop detectors, video cameras, and range sensors have deficiencies.
Introduction (Cont.)

- **Loop detectors** have high failure rates due to pavement failures and poor maintenance.

- **Video** based classification systems do not perform well in deteriorated atmospheric conditions (such as rain and fog).
Using range sensors, classification is based on height data or intensity images,

- height data based classification systems do not perform well in deteriorated atmospheric conditions
- intensity image based classification systems offer the promise of sensors that are less sensitive to deteriorated environmental conditions.
Laser Intensity Automatic Vehicle Classification System (LIAVCS)

- Our Laser Intensity Automatic Vehicle Classification System (LIAVCS) is an intensity image based range sensor.

LIAVCS is a pattern recognition system that relies on special image processing and computer vision algorithms to extract vehicle features.

These features include: vehicle length “L”, max. width “W”, speed “S”, the difference between max. and min. width “DW”, max. height “H”, and % of edge points “E”.
Vehicles classes are: motorcycles, passenger cars, pick-up or van, trucks, and buses (class 1 through 5).

If any of these vehicles has a trailer, it can be automatically detected.

The classification is done without using any type of electronic tags (transponders) mounted on the vehicle.
Random Neural Network (RNN)

- The RNN represents more closely the manner in which signals are transmitted in many biological neural networks, where they travel as spikes.

- Signals in the form of spikes of unit amplitude circulate among the neurons. Positive signals represent excitation and negative signals represent inhibition.

- Each neuron's state has a non-negative integer (neuron potential), which increases when an excitation signal arrives to it; and decreases when an inhibition signal arrives.

The architecture of the employed RNN consists of six input neurons (extracted features), six output neurons (vehicle classes), and ten hidden neurons.
Experimental Procedure

- A large database of vehicle intensity images taken in bad weather condition (fog and rain), with their ground truth database was used.

- Two stages were considered
  - **1st Stage:** Training the RNN using a set of 800 vehicles.
  - **2nd Stage:** Testing our system using 4955 vehicles
In training the RNN, the training was achieved in about 100,000 iterations.
In testing the LIAVCS, out of 4955 vehicles only 435 were misclassified (8%).

<table>
<thead>
<tr>
<th>Vehicle Class</th>
<th>Motorcycle</th>
<th>Passenger car</th>
<th>Pick-up or van</th>
<th>Single unit truck or bus</th>
<th>Tractor trailer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misclassification</td>
<td>7/15 (47%)</td>
<td>218/ 1986 (11%)</td>
<td>129/ 2158 (6%)</td>
<td>81/ 508 (16%)</td>
<td>0/ 288 (0%)</td>
</tr>
</tbody>
</table>
Conclusions

- **Our Laser Intensity Automatic Vehicle Classification System (LIAVCS)** is an intensity image based range sensor. The LIAVCS is capable of working robustly under most circumstances.

- The inputs to LIAVCS are vehicle intensity images recorded using laser sensory units.

- The output of LIAVCS is one of five major classification categories: motorcycle, passenger car, pick-up or van, single unit truck or bus, and tractor-trailer.
Conclusions (cont.)

- In addition to the vehicle category, LIAVCS provides height, width, length and velocity information for each vehicle.

- The LIAVCS has been tested using a large database of vehicles. Only 8% misclassification were recorded (435 out of 4955).

- LIAVCS outperforms the height data based classification technique, in particular under adverse weather conditions.

- Our approach can be used in many real world systems such as the vehicle verification system in toll collecting.
Thank You