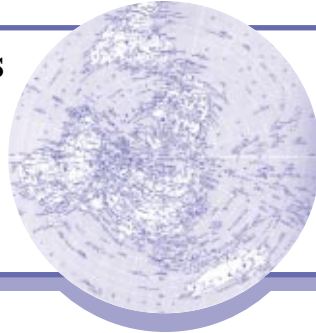


## MONITORING WEAVING SECTIONS

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### Why This Research is Needed

Freeway “weaving sections,” where an entrance ramp is closely followed by an exit ramp, are areas of complex vehicle movement as drivers change lanes, overtake other vehicles, and change speeds rapidly. It is difficult for traffic researchers to gather accurate data about these areas, because commercially available monitoring systems are unable to accurately track vehicles under these difficult conditions.

### Research Objective

To develop a traffic monitoring system based on vision sensing that can gather accurate data on complex vehicle movements in highway weaving sections.

### Methodology

Because the ultimate goal is to create a vision-based system, algorithms developed for the purposes of this study were tested on several weaving sections under varying atmospheric conditions to evaluate possible interference by rain, fog, or other effects of weather. The algorithms are based on the establishment of correspondences between the vehicles moving through the weaving section and the “blobs” of pixel data which the camera feeds to the processing unit. For the purpose of data processing, this “blob tracking” task is formulated by the computer as a bipartite graph optimization problem. A calibration tool was also developed, which uses a graphical user interface (GUI) to allow users to set up the equipment for different camera positions.



*Detector view showing multiple vehicles being tracked in a weaving area*

### Research Results

When implemented on a dual-Pentium 200 MHz PC, the system achieved accurate tracking at 15 frames per second even for the most cluttered scenes, monitoring four lanes. Testing was conducted under a variety of conditions, including different lighting, camera placements, and average vehicle speeds (e.g., during rush hour); the system was able to track most vehicles successfully (85% average accuracy) and provided accurate trajectory information. Ground truth was established through manual counters.

The system dealt well with partial occlusions of one vehicle by another; however, because it uses a fixed-size model to represent vehicle objects, the system sometimes failed to track large trucks, which can completely obscure other vehicles.

## **Research Impacts**

Dr. Eil Kwon, director of the advanced traffic systems program at the Center for Transportation Studies, is using the monitoring system and processing algorithms developed in this research project to gather data for his research on weaving sections. The ability to gather accurate data is crucial to Kwon's search for ways to better manage traffic flow in bottleneck areas.

Engineers in the Minnesota Department of Transportation Traffic Management Center are also utilizing the newly developed algorithms to visualize weaving-section data in new ways—for example, for more accurately determining the effective weaving zone for different interchange layouts.

## **What's Next**

Future work on the tracking system will improve performance in monitoring large vehicles accurately and further increase accuracy by enabling the system to compensate for difficult lighting conditions. Detailed analysis of new tracking data may lead to further refinements in the tracking algorithms.