Vision-Based Road Safety Analysis

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Outline

1. Motivation
2. Feature-based Tracking
3. Automated Road Safety Analysis
4. Experimental Results
5. Conclusion and Future Work

1. Motivation

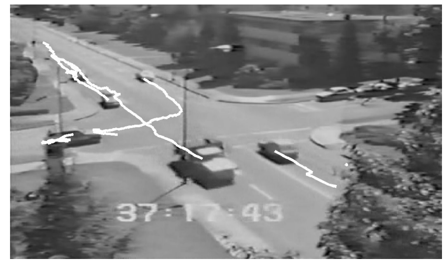
- Main bottlenecks for manual data collection
  - collection cost,
  - reliability and subjectivity of human observers.
- Advantages of video sensors
  - they are easy to install,
  - they can provide rich traffic description (e.g. vehicle tracking),
  - they can cover large areas,
  - they are cheap.

1. Assistant System

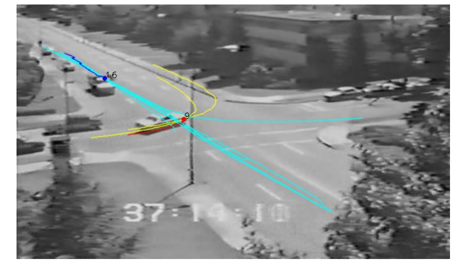
http://www.chelmsford.gov.uk/media/image/m/d/Monitor_wall_(o)_large.jpg

1. A Modular System

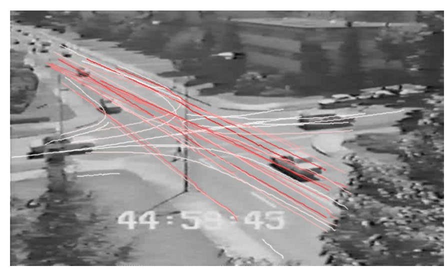
Image Sequence



Trajectory Database



Interaction Database



- Motion Patterns
- Volume, Origin-Destination Counts
- Driver Behavior...

- Traffic Conflict Detection
- Exposure Measures
- Interacting Behavior...

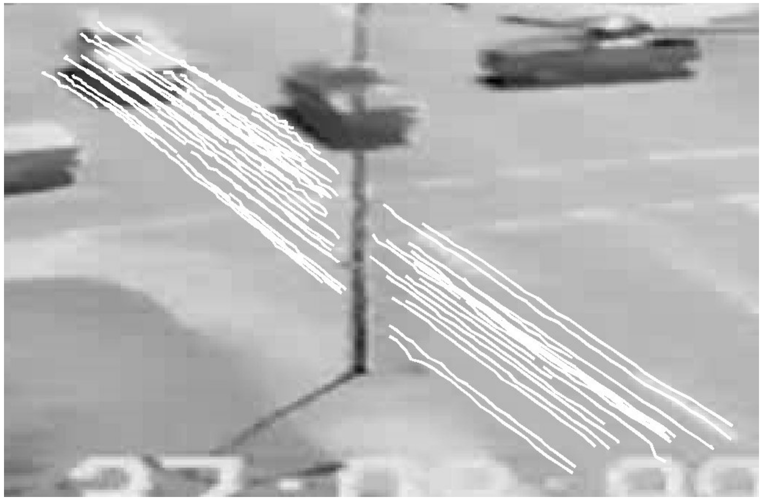
Interpretation Modules

2. Feature-based Tracking

- Feature-based tracking computes the displacement of pixels with distinct features between two images.
- Road user tracking is achieved by grouping features with similar movement.
- It is robust to partial occlusion, variable lighting conditions, and requires no special initialization.

2. Feature-based Tracking

- Accuracy between 84.7 % and 94.4 % on 3 sets of sequences.

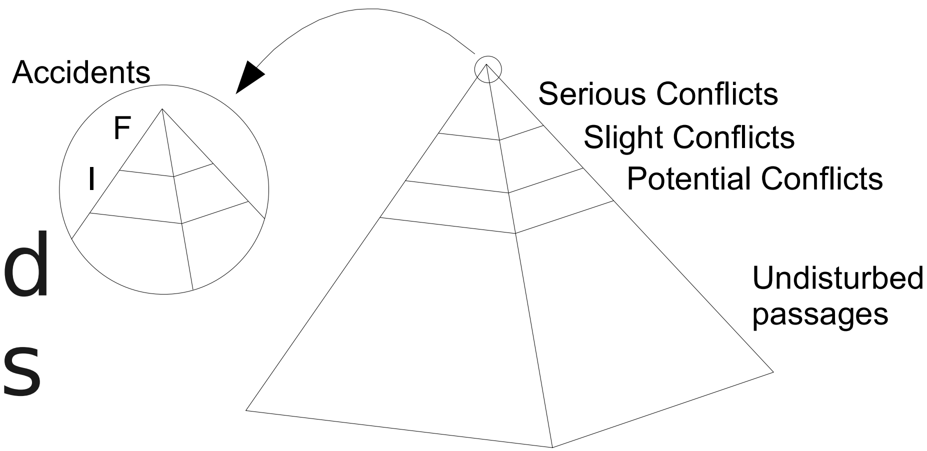


3. Road Safety

- Traditional road safety reactive approach, based on historical collision data.
- Pro-active approach: "Don't wait for accidents to happen".
- Need for surrogate safety measures that provide complementary information and are easy to collect (more frequent).
- Traffic conflicts (near-misses).

3. The Collision Probability

- The safety/severity hierarchy.

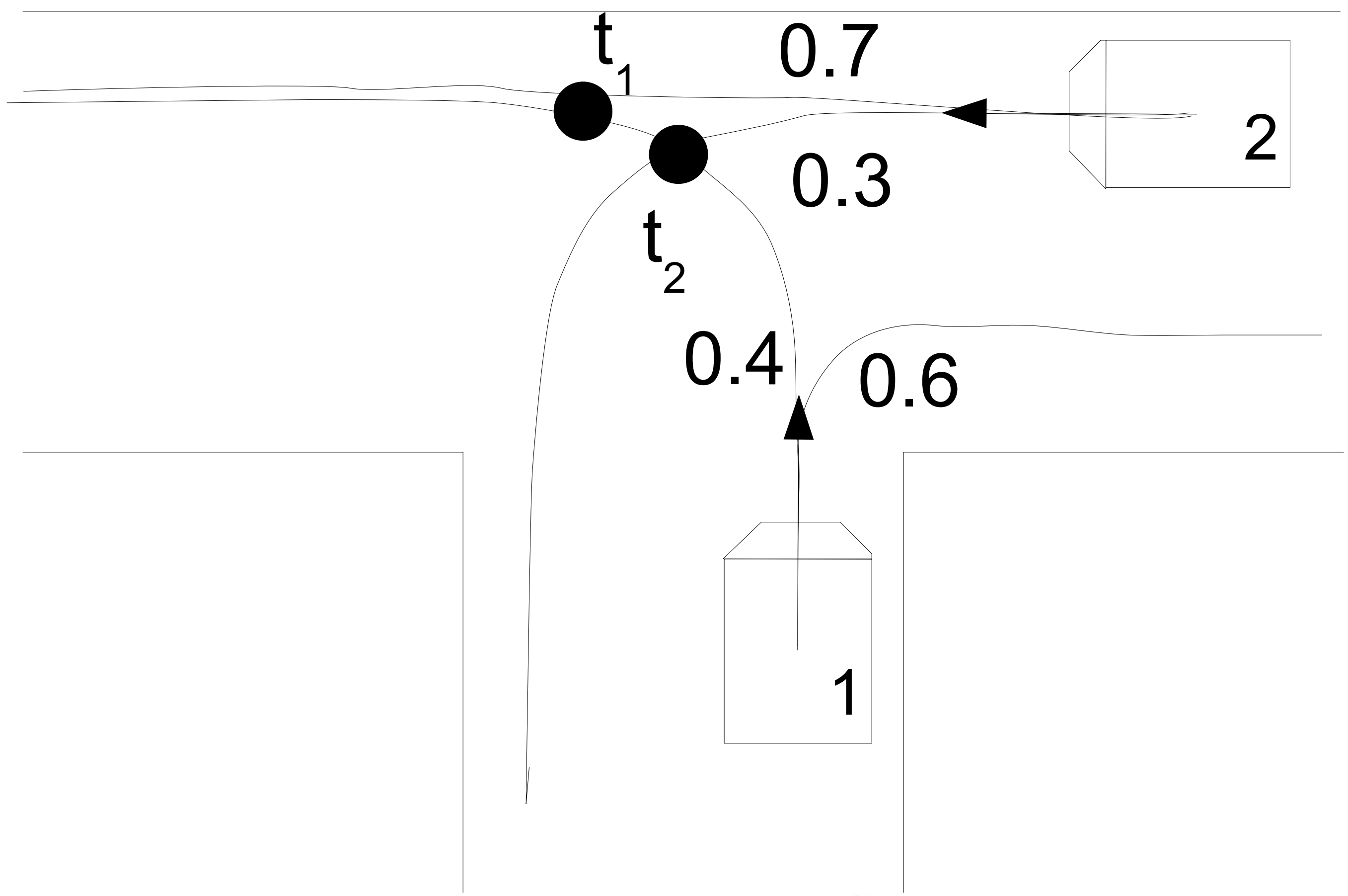


- For two interacting road users, there are various chain of events that can lead to a collision.
- Given extrapolation hypotheses for road users, $P(Collision(A_1, A_2)|H_i, H_j) = e^{-\frac{\Delta_{i,j}^2}{2\sigma^2}}$

$$P(Collision(A_1, A_2)|Q_{1,t\leq t_0}, Q_{2,t\leq t_0}) =$$

$$\sum_{i,j} P(H_i|Q_{1,t\leq t_0})P(H_j|Q_{2,t\leq t_0})\ e^{-\frac{\Delta_{i,j}^2}{2\sigma^2}}$$

3. Simple Example



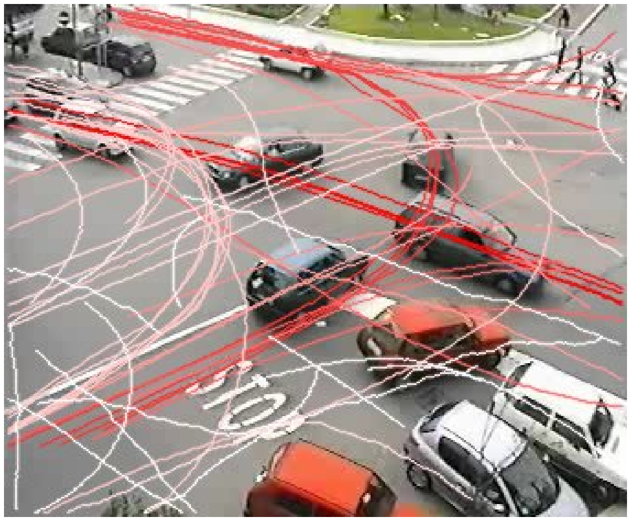
$$P(Collision) = 0.4 \times 0.7 \times e^{-\frac{(t_1 - t_0)^2}{2\sigma^2}} + 0.4 \times 0.3 \times e^{-\frac{(t_2 - t_0)^2}{2\sigma^2}}$$

3. Motion Patterns

- Need to predict road users' future positions to compute the collision probability.
- Road users do not move randomly. Typical road users movements, traffic motion patterns, can be learnt from the observation of traffic data.
- Incremental learning of trajectory prototypes.

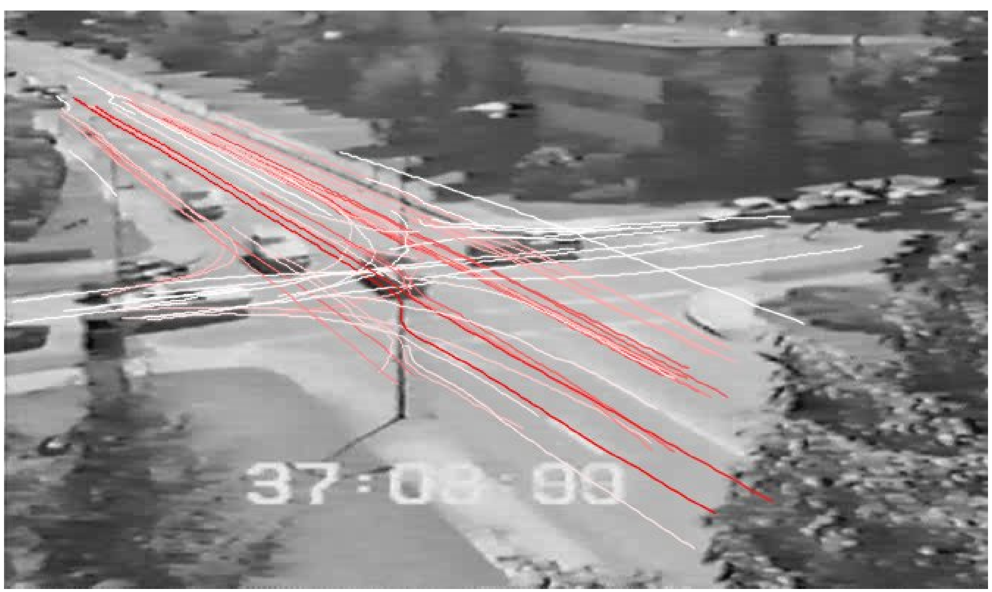
4. Experimental Results

4. Motion Patterns



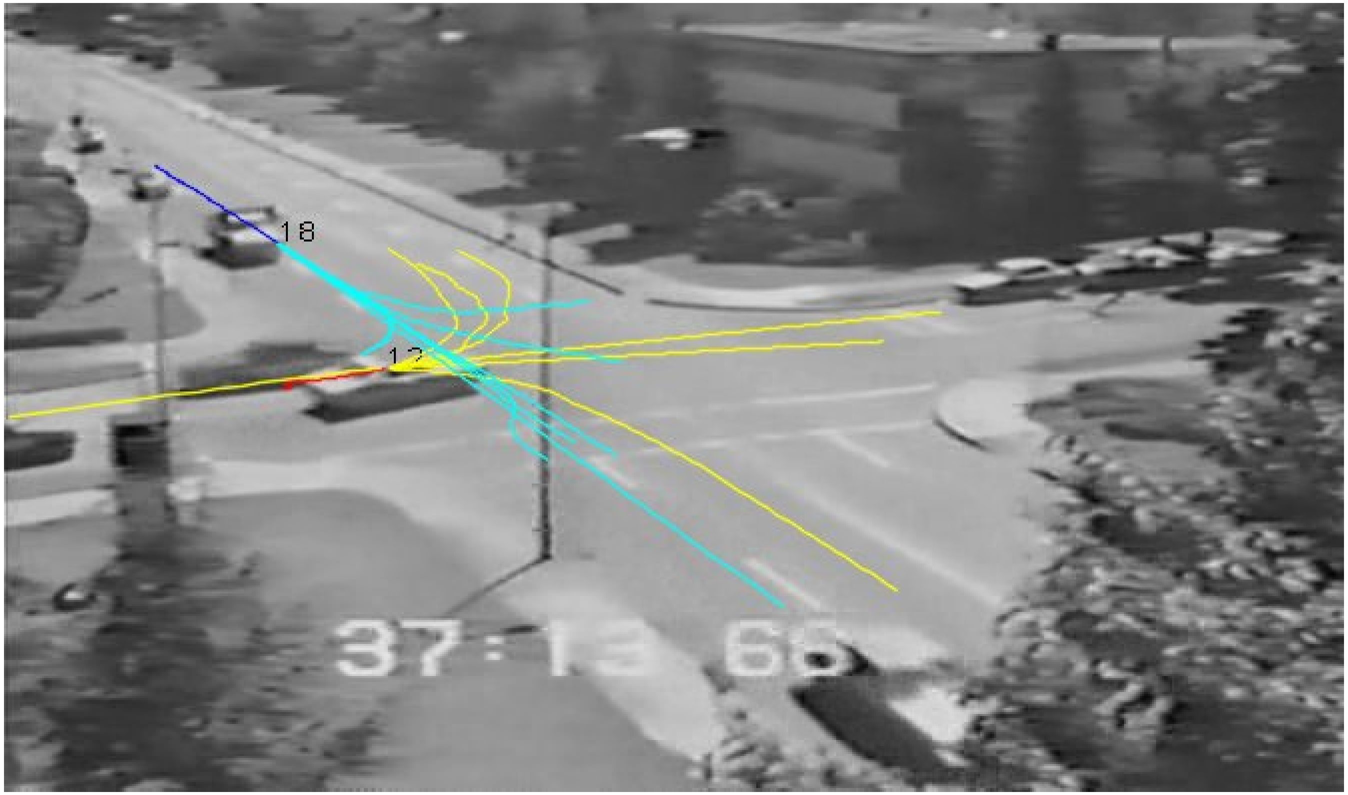
58 prototype trajectories
(138009 trajectories)

128 prototype trajectories
(88255 trajectories)

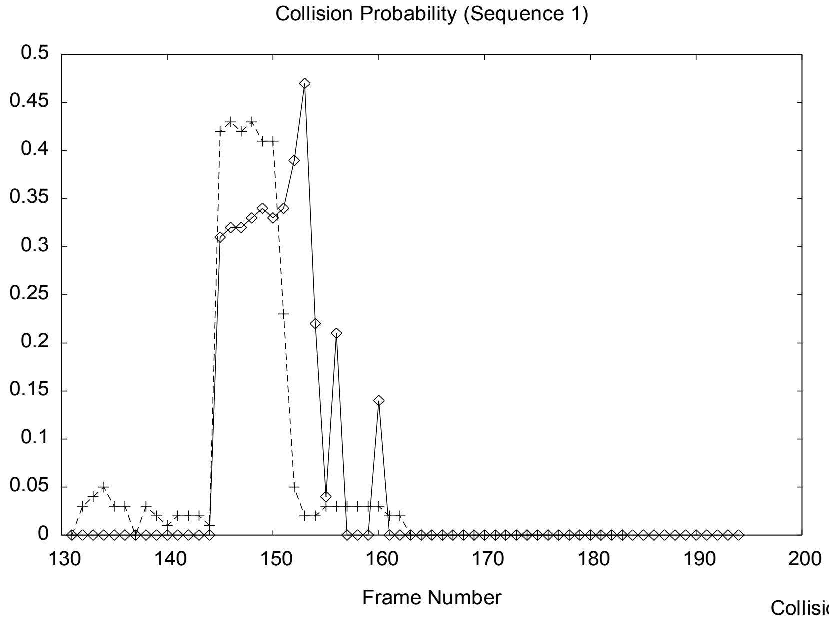


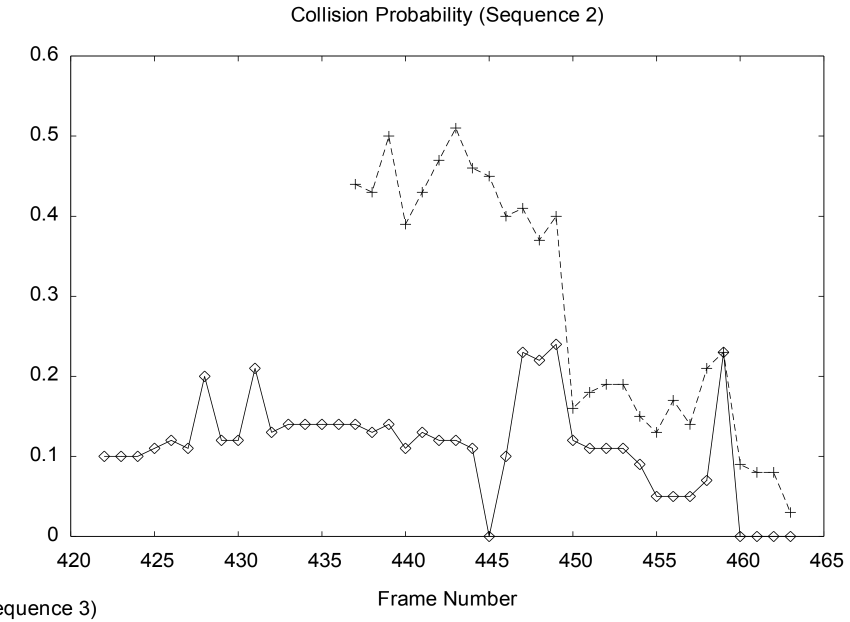
58 prototype trajectories
(2941 trajectories)

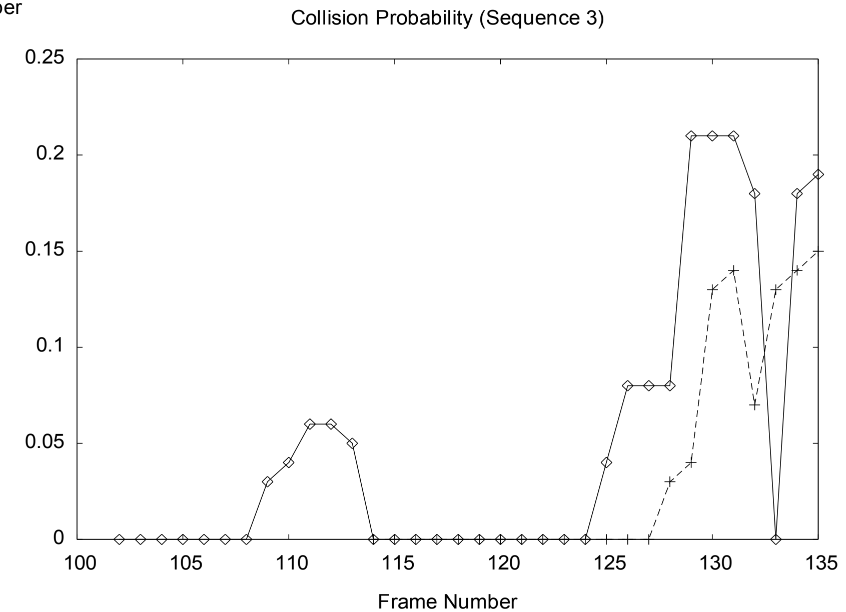
4. Traffic Conflicts



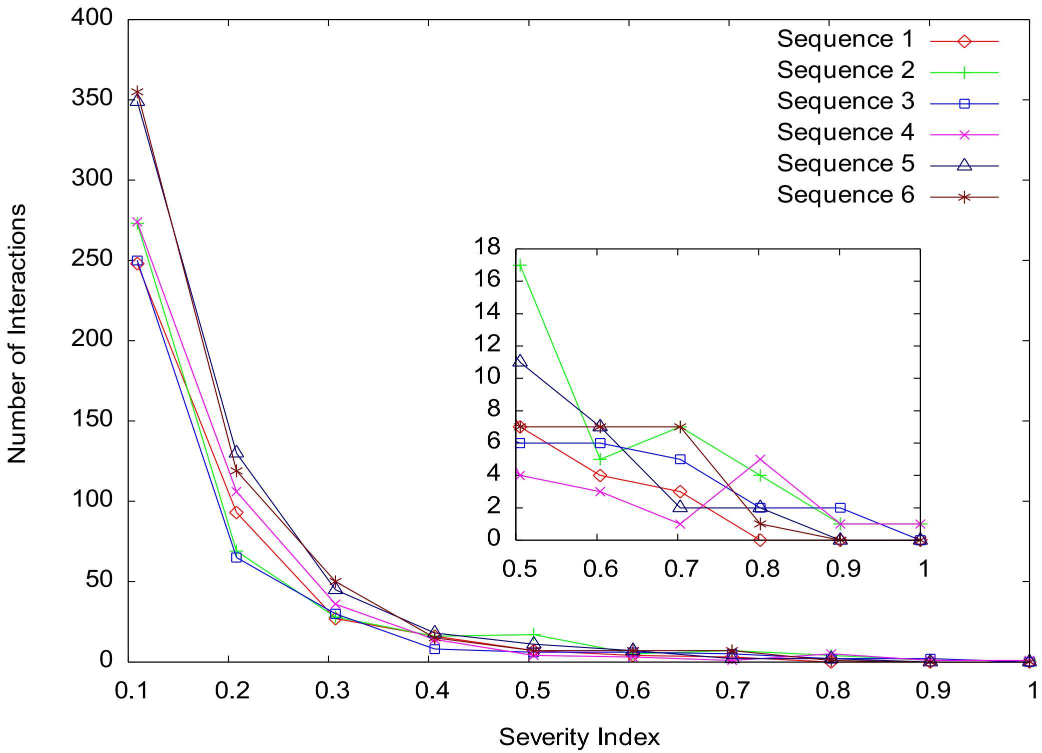
4. Collision Probability

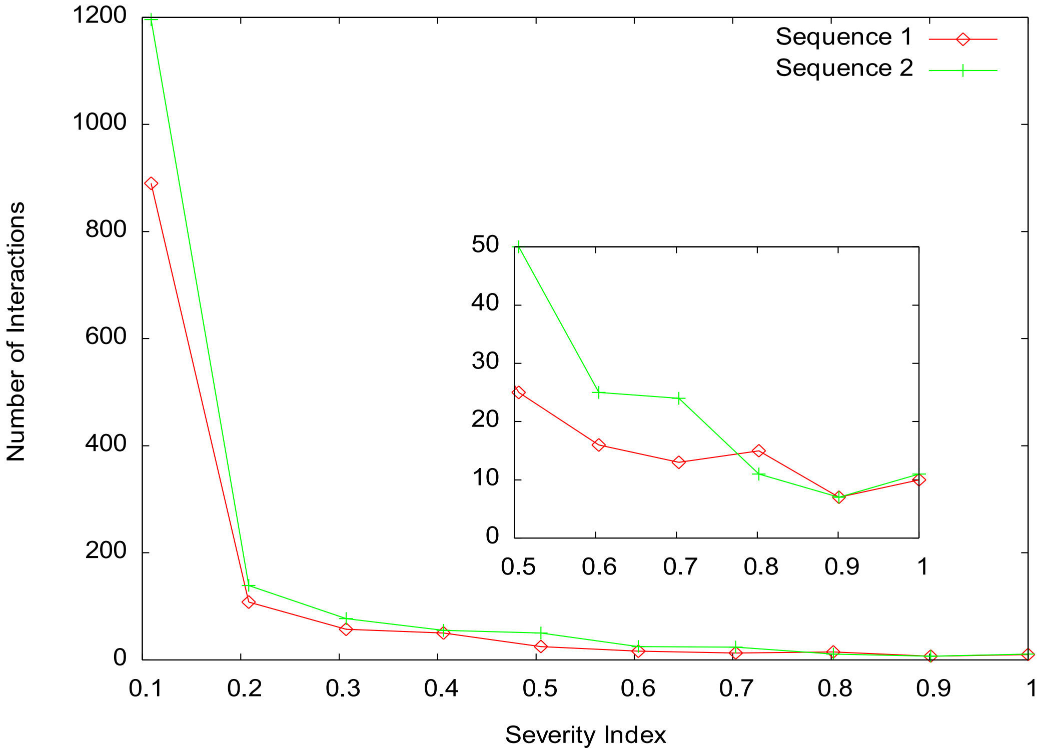






4. Severity Index





5. Conclusion

- Complete system for automated traffic data collection: traffic intelligence.
- Probabilistic framework for automated road safety analysis.
- Robustness and versatility of feature tracking.

5. Future Work

- Improve vehicle detection and tracking: detect shadows, estimate vehicle size.
- Extensions:
  - Road user identification: trucks, buses, vehicles, two-wheels and pedestrians.
  - Smart corridor project and Vehicle Integrated Infrastructure.
  - Pedestrian tracking and modeling.

THANK YOU !