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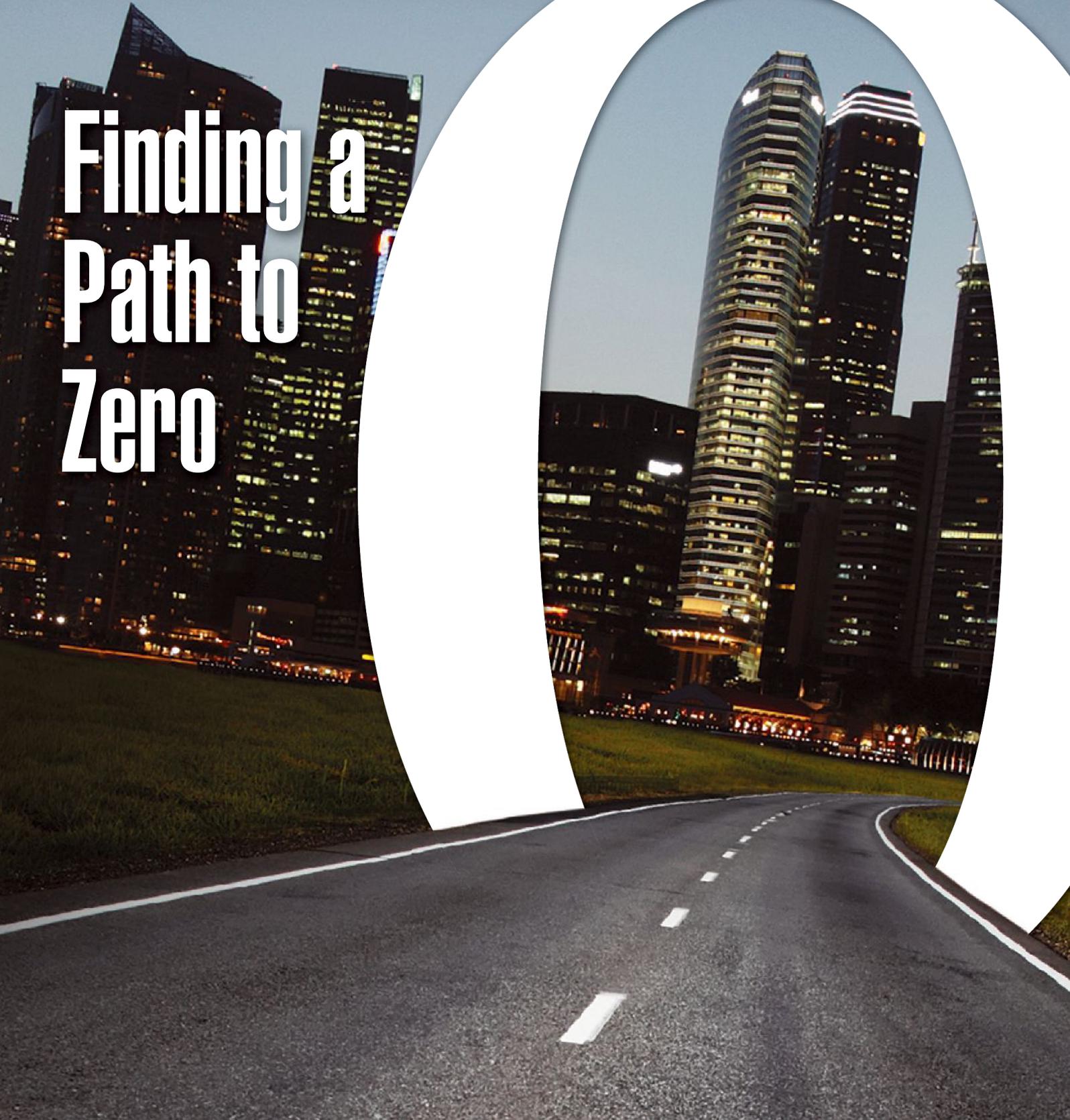
Video Analytics Towards Vision Zero

By Franz Loewenherz, Victor Bahl, Ph.D., and Yinhai Wang, Ph.D.

For young people below the age of 35, motor vehicle crashes are the leading cause of death in the United States. In 2015, collisions resulted in 35,092 deaths and 2.4 million injuries. More than 1,100 children under the age of 15 were killed. The 7.2 percent increase in traffic fatalities from 2014 to 2015 represents the greatest percentage increase in nearly 50 years.[1] Yet despite the massive death toll, work to prevent traffic fatalities has been woefully lacking.

Many governmental agencies continue to rely on traditional traffic safety approaches. They intervene only after enough police crash reports are filed to trigger a High Crash Corridor designation. This reactive approach to preventing crash recurrence has well-documented limitations:

- At most locations, the number of crashes is very small and subject to chance variations;
- Not all crashes are reported and the level of reporting is uneven regarding the type of road users involved, the exact location, and the severity of injuries;
- Numerous "close calls" go undocumented; and
- Many years of crash data are typically required to develop an understanding of the situation.[2]

Given these trends, and the crash analysis tools presently employed, how will jurisdictions achieve what all of us want: zero fatalities and serious injuries on our roadways? That's the goal of Vision Zero, an international movement that responds to what is one of the leading causes of death worldwide.[3] It calls on government agencies to be proactive, identify risks, and take steps to prevent injuries on our roadways. Vision Zero encourages us to imagine a future in which we do not need to wait for crashes to occur in order to prevent others from happening.[4]

Solutions for a Safer World

Although traffic collisions can happen anywhere, there are often early warning signals in the form of conflicts or near-collision events at specific locations. These are recurring instances where a car abruptly stops because a bicycle veered in front of it, a pedestrian steps into the path of a bicyclist, or one bicyclist or car passes by another or a static object at very close spacing. These surrogate warning indicators – observable non-crash traffic conflict events – provide insight into when, where, and why crashes are most likely to occur. Understanding the root causes for near-collision events could enable local governments to take proactive, corrective actions to reduce the potential for future crashes.[5]

Although stand-alone data processing systems exist for analyzing near-collision events from pre-recorded video, these methods can only be captured for a discrete number of sites over a defined time period.[6] Digital transformation is fundamentally reshaping transportation analytics, thanks to the rise of cloud computing, machine vision systems based on deep neural networks, and other disruptive innovations.[7] These new technologies are able to convert raw video footage from an existing camera network into useful data that can be searched, managed, and used to provide traffic management centers with detailed information on traffic flow, speeds, and other vehicle conditions, and allow a more rapid response to traffic incidents.

Video Analytics: Big Data, Big Opportunities

In recognition of the opportunities to enhance traffic operations and public safety, Microsoft Corp., the City of Bellevue, WA, USA, and University of Washington (UW) have entered into a technology development partnership. Figures 1 through 4 show how the collaboration will leverage the city's existing traffic cameras to generate count reports that classify vehicles by turning movement (through, left or right), by direction of approach (northbound, southbound,

etc.) and by mode (car, bus, motorcycle, truck, bicycle, pedestrian). In addition to data on the type and motion of road users at intersections, speed and derivatives of speed (e.g., acceleration and jerk) can be calculated continuously to better understand steering and braking behaviors. These data have the potential to identify near-collision events, such as when a car abruptly stops or swerves to avoid striking a pedestrian. These close calls are much more frequent and more useful than actual crash reports in detecting systemic safety problems.

Performance dashboards are under development to flag high-risk locations that warrant intervention. The dashboards are based on a predetermined, numeric scale of near-collision conditions. A higher score indicates a higher risk of collision, adjusted for the number of road users passing through the intersection. In terms of human lives and property damage, near-collision events are zero-cost learning opportunities, compared to learning from actual crashes and their grim consequences. The National Highway Traffic Safety Administration (NHTSA) has quantified the economic and societal impact of crashes in the United States at more than $800 billion annually.[8]
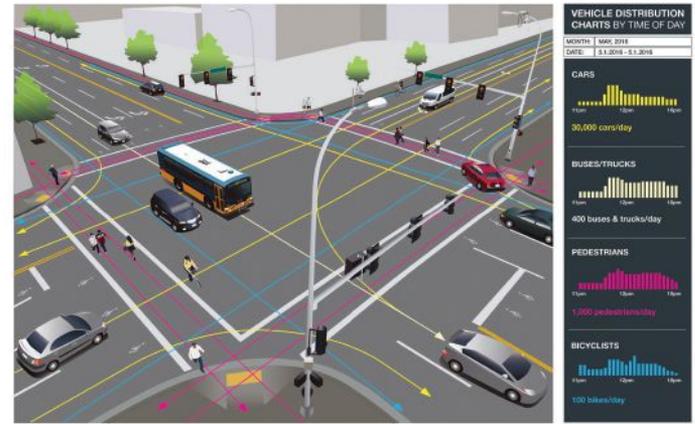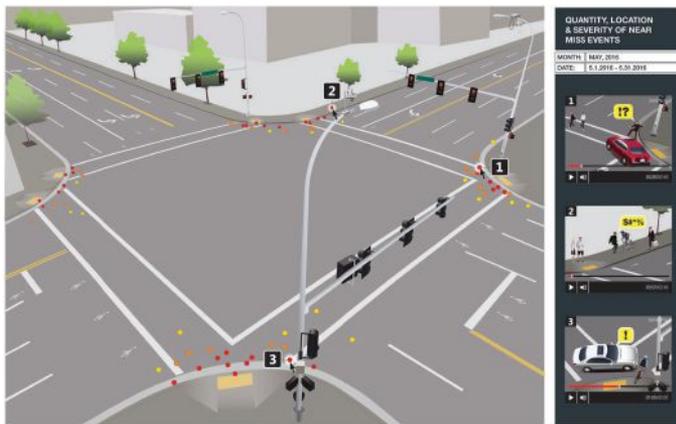

Figure 1.

Figure 2.

Figure 3.

Figure 4.

Computer images showing how the Video Analytics partnership will leverage existing traffic cameras to generate count reports.

Underlying the video analytics platform is a tracker technology that is tuned to detect and follow the trajectory of moving objects across varying camera views, lighting, and weather. Figure 5 shows the objects are classified into relevant categories – for example, pedestrians, bicycles or cars–using a Deep Neural Network (DNN), a machine learning system inspired by the central nervous systems of animals. The video analytics platform executes these vision techniques as a chain of components on a distributed cluster of many machines. The platform is fault tolerant to automatically detect and restart execution on failures, thus ensuring that the analytics outputs are produced 24x7 on live video.

Crowdsourcing: An Invitation to Make our Intersections Smarter and Safer

To help the tracker and DNN technologies, Microsoft, Bellevue, and the UW are collaborating with several partners to develop and promote a crowd-sourcing platform that invites the public to participate in annotating videos from pre-recorded traffic camera footage.

- **Government**: The U.S. cities of Los Angeles and San Francisco, CA, New York, NY and Seattle and Redmond, WA; Snohomish and King counties in Washington, and Washington State Department of Transportation; and the cities of Calgary, Vancouver and Hanover, Ontario in Canada;
- **Non-Profit**: The Institute of Transportation Engineers (ITE), Intelligent Transportation Society of America (ITS America), Vision Zero Network, Cascade Bicycle Club, and People for Bikes.
- **Research**: University of British Columbia, McGill University, **École** Polytechnique de Montréal, and Lund University.

Crowdsourcing—in which online volunteers annotate pre-recorded videos—will be used to train the vision and DNN technologies to understand enormous quantities of data. Each video file will be independently by multiple volunteers and their responses aggregated using a variety of algorithms to determine what is in a given image.

ITE, along with ITS America and the Vision Zero Network, have agreed to host the Video Analytics towards Vision Zero
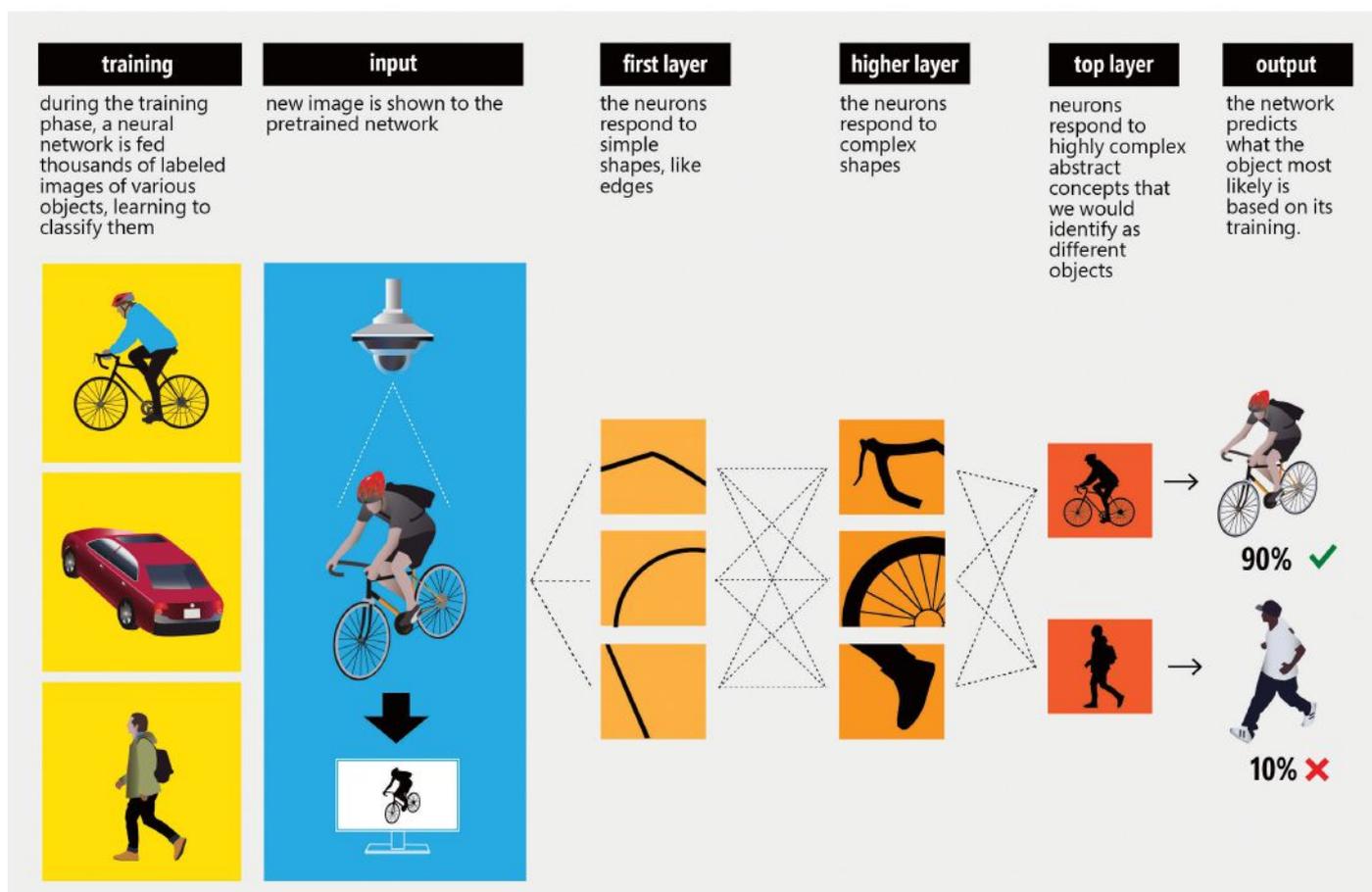
HOW NEURAL NETWORKS WORK

Figure 5. Graphic showing how objects are classified using a Deep Neural Network.

crowdsourcing platform on their websites. The following are two ways that interested ITE members can join this partnership:

- Provide network links to traffic cameras that will be used to record video and leveraged in the public-facing crowdsourcing platform to enhance the deep learning algorithms under development. (Timeline: March-April 2017)
- Promote the crowdsourcing platform—to be made available via the ITE website—to interested stakeholders. (Timeline: May-June 2017)

This collaboration amongst corporate, government, research, and non-profit institutions, paired with community volunteers via crowdsourcing, represents an exciting opportunity to enhance the accuracy of the video analytics system under development. Together we are relying on a version of the "wisdom of crowds" to take full advantage of the opportunities presented by this technological innovation. Together we can make our future transportation system safer and move toward Vision Zero.

Please contact Franz Loewenherz, project manager of the Video Analytics towards Vision Zero Partnership, at +1-425-452-4077 or floewenherz@bellevuewa.gov to learn more about how your own organization can collaborate in this partnership. **itej**

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Franz Loewenherz *is a Principal Transportation Planner for the City of Bellevue. He received his master's degree in urban planning from the University of Washington and has more than 20 years of transportation sector experience. Franz has advanced multiple technology development partnerships including overseeing a team from the City of Bellevue, King County, and Federal Highway Administration that leveraged inertial profiling technologies to identify sidewalks with defects that limit access for persons with disabilities. Mr. Loewenherz is project manager of the Video Analytics towards Vision Zero Partnership aimed at developing a predictive crash analysis system for flagging road safety problems.*

Victor Bahl, Ph.D. *is a distinguished scientist and director of mobility & networking research at Microsoft. He advises Microsoft's CEO and senior leadership team on long-term vision/strategy for networked systems and cloud computing. He leads a high-powered group that executes on this vision through research, technology transfers to product groups, industry partnerships, and associated policy engagements with governments around the world. Victor has published more than 125 scientific papers, authored more than 130 patents, and won numerous technical and leadership awards including a lifetime technical achievement award. He is a Fellow of the Association for Computing Machinery, Institute of Electrical and Electronics Engineers, and American Association for the Advancement of Science.*

Yinhai Wang, Ph.D. *is a professor in transportation engineering and the founding director of the Smart Transportation Applications and Research Laboratory (STAR Lab) at the University of Washington (UW). He also serves as director for Pacific Northwest Transportation Consortium (PacTrans), USDOT University Transportation Center for Federal Region 10 and visiting chair for the Traffic Information and Control Department at Harbin Institute of Technology. He has a doctorate in transportation engineering from the University of Tokyo (1998) and a master's degree in computer science from UW. Dr. Wang's active research fields include traffic sensing, e-science of transportation, big-data analytics, transportation safety, etc. He has published more than 120 peer reviewed journal articles and delivered more than 130 invited talks and nearly 220 other academic presentations.*