VIP Cup 2017
Video and Image Processing Cup

This competition is sponsored by the *IEEE Signal Processing Society (SPS) MMSP TC*.

Traffic Sign Detection under Challenging Conditions

1. Competition Overview

Robust and reliable traffic sign detection is necessary to bring autonomous vehicles onto our roads. State of the art traffic sign detection algorithms in the literature successfully perform the task over existing databases that mostly lack challenging road and environmental conditions. This competition focuses on detecting such traffic signs under challenging conditions.

To facilitate such task and competition, we introduce a novel video dataset that contains a variety of road conditions. In such video sequences, we vary the type and the level of the challenging conditions including a range of lighting conditions, blur, haze, rain and snow levels. The goal of this challenge is to implement traffic sign detection algorithms that can robustly perform under such challenging environmental conditions.

2. Competition Organization

The competition is open to any team that is eligible to participate and make a submission, which is due ***July 1, 2017*** and the finalists of the competition are announced by ***August 1, 2017***. Finalists will be selected by the organizers of the competition and will be invited to ICIP 2017 based on the overall performance whose details will be announced when the database is released on ***March 15, 2017***. A judging panel will evaluate the three finalists to determine the ultimate winners at ICIP 2017, which will be held ***September 17-20, 2017***. In addition to algorithmic performances, demonstration and presentation performances will also affect the final ranking. Presentations will be followed by questions of judging committee and general audience.

3. Database Overview

We introduce a novel video dataset whose sequences include processed versions of captured traffic videos and synthesized videos. The simulated environmental conditions include extreme lighting conditions, blur, haze, heavy rain and snow. These conditions span a wide range of challenging levels from mild to severe. The participants are expected to design a traffic sign detection algorithm that robustly works for the introduced challenging conditions.

4. Detailed Description

Current transportation technologies shape our industry and landscape. Transportation-related goods and services account for more than $1 trillion of U.S Gross Domestic Product [1]. High-ways, roads, and parking lots consume a significant portion of our cities and dictates their designs. The technological enhancements shape the practices in transportation systems and autonomous driving is a good example that has the potential to transform current systems. Robust understanding of a scene is vital to have autonomous cars in our roads without subjective intervention and traffic sign detection is one of the most critical challenges in scene understanding for autonomous vehicles. Because of its significance, the researchers have conducted various studies to solve the traffic sign detection issue in the literature [2-12].

The authors in [2] provide an overview of existing traffic sign detection methods by categorizing the main components of these approaches into three classes as detection, classification, and temporal integration. They also propose a shape-based method and validate the detection performance through offline and online experiments. Even though the authors claim that challenging environmental conditions affect the detection accuracy, they do not analyze the relationship between these conditions and their effects. In [3], the authors conduct a survey of the traffic sign detection literature with a focus on driver assistance systems. The public sign databases described in this survey include *German Traffic Sign Recognition Benchmark (GTSRB)* [4, 5], *Belgium Traffic Sign Data Set (BelgiumTS or KUL)* [6], *Swedish Traffic Signs (STS) Data Set* [7], *Traffic Sign Database* by *Petkov et al.* [8], and *Stereopolis Database* [9]. In addition to *GTSRB* and *BelgiumTS*, *German Traffic Sign Detection Benchmark* [10] and *Belgium Traffic Sign Classification* (BTSC) [11] database are also utilized in the literature [12]. However, these traffic sign detection and recognition databases do not address the relationship between challenging environmental conditions and algorithmic performance.

In order to fully realize self-driving cars, we need to utilize algorithms that can successfully operate under real life challenging conditions. Self-driving cars should be capable of recognizing traffic signs in day and night under various visibility conditions. Speed of the car, lighting conditions, haze, rain and snow can lead to significant challenges for detection and recognition algorithms. To serve this competition and to analyze the effect of challenging conditions in traffic sign detection performance, we introduce a novel video dataset, which includes processed versions of captured traffic videos and synthesized videos. Challenging conditions include extreme lighting conditions, blur, haze, heavy rain and snow and the level of these conditions vary from mild to severe. We provide examples corresponding to motion blur, rain, and extreme lighting conditions in *Fig. 1*, *Fig. 2*, and *Fig. 3*.

The most common approach to collect driving data is to mount cameras on a car, drive the car around to record videos, and then process the videos to build a database. However, there are several drawbacks in this approach: First, it consumes considerable time. Second, and more importantly, it is impossible to control environmental factors and capture the same scene under varying environmental conditions. In other words, if we want to record the same scene at different times to make a controlled experiment, we need to keep everything identical at all times of recording except for the environmental condition that we want to vary. Apparently, it is not possible to control all environmental and surrounding conditions. For instance, we cannot guarantee following exactly the same route every time. Moreover, there are several other factors that are difficult to control including the intensity of a weather phenomenon such as rain or the intensity of street lamps. We cannot simulate various conditions without a complete 3D model of the scene. For example, in heavy rain conditions, the rain direction changes in accordance to the car speed and direction with respect to the camera point of view. Similarly, lighting exposure is directly related to the sun position and intensifies accordingly.

Fig. 1. Sample images that are processed to simulate motion blur.

Fig. 2. Sample images that are processed to simulate rain.

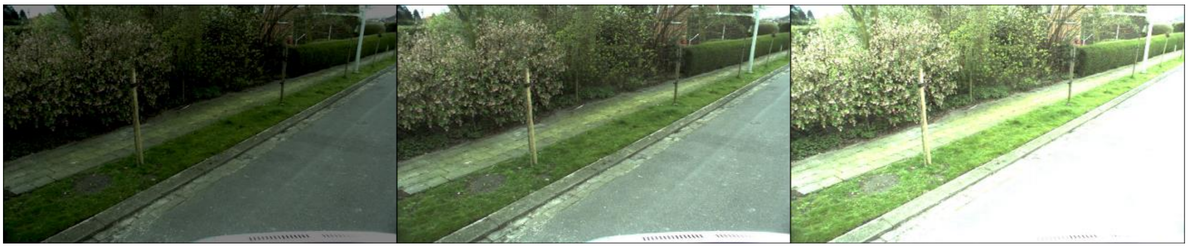

Fig. 3. Sample images that are processed to simulate extreme lighting conditions.

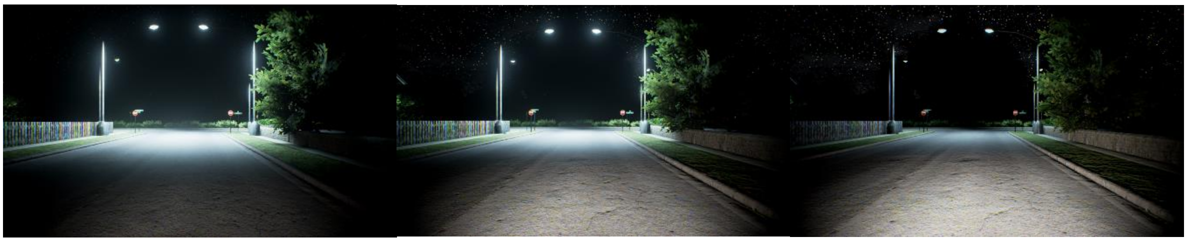

Fig. 4. Sample images with different street light intensities.

To complement the limitations of captured sequences, we generate synthesized videos using a professional game development tool. To simulate the driving experience, we created a simple car-driving game including a car object and a mounted camera. To avoid manually controlling the car, we generated a path that is followed by the car object. Therefore, we generate training and testing sequences by recording the game. In *Fig. 4*, we provide example images in which intensity of the street lights are systematically controlled and in *Fig. 5*, we show examples of different weather conditions.

Fig. 5. Sample images with different weather conditions.

In this competition, we ask participating teams to design and implement traffic sign detection algorithms that can robustly perform under challenging environmental conditions. Proposed algorithms are expected to recognize traffic signs in both real world videos and synthesized sequences without utilizing upcoming frames for current prediction. We will provide a detailed description of the requirements and the database on ***March 15, 2017***.

5. Formation of Competition Teams

Each team is to be composed of one faculty member (as the supervisor), at most one graduate student (as a tutor/mentor), and at least three but no more than 10 undergraduates. At least three of the undergraduate team members must be either IEEE SP members or student members.

6. Submissions form Participating Teams and Evaluation

All of the submissions must be received by ***July 1, 2017***. Each submission should include a report, in the form of an IEEE conference paper, up to 6 pages, on the technical details of the methods used and programs developed. The organizing committee will evaluate the submissions. By ***August 1, 2017***, the best three teams will be identified to participate in a session for the final competition, to be held at ICIP 2017. The details of the submission process and evaluation will be provided by ***March 15, 2015***.

7. Final Competition at ICIP 2017

A maximum of three members from each of the three teams selected will be paid to attend ICIP 2017 for the final competition. More members are also welcome to attend, but they will not be provided with any travel grant. In addition, those team members who will not be presenting a paper at the conference will be offered a complimentary ICIP registration. A Judging Panel (composed of members of the TC concerned and other TC Chairs) will be set up to pick the ultimate winners at the conference. The teams need to present the technical details regarding how they solve the challenging problem, and demonstrate their results at a session. In addition to algorithmic performances, demonstration and presentation performances will also affect the final ranking. Presentations will be followed by the questions of judging committee and general audience.

8. Important Dates

Call for Competition	February 15, 2017
Data are Available Online	March 15, 2017
Submission Deadline	July 1, 2017
Announcement of Best Three Teams	August 1, 2017
Conference	September 17-20 2017

9. Budget

Each team member is offered up to $1,200 for continental travel or $1,700 for intercontinental travel, and at most three people from each team will be supported. The participants can claim their travel expenses on a reimbursement basis. Furthermore, the selected teams will be invited to join the Conference Banquet as well as the Student Career Luncheon so that they can meet and talk to SPS leaders. The prizes offered to the three teams for each of the categories in the final competition are suggested to be as follows:

The champion: $5,000
The first runner-up: $2,500
The second runner-up: $1,500

10. Links and Resources

The official announcement of the VIP cup on the IEEE SPS website can be found at: http://signalprocessingsociety.org/get-involved/video-image-processing-cup.

All updates, news, and information on the competition throughout the course of the competition can be found at: https://ghassanalregib.com/vip-cup/

11. References

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