

TxDOT Video Analytics System User Manual

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TxDOT VA System User Manual

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1 System Overview

1.1 System Structure Overview

The TxDOT video analytics demonstration system is designed to monitor traffic conditions by collecting data such as speed and counts, detecting incidents such as stopped vehicles and reporting such incidents to system administrators.

As illustrated in Fig. 1.1 there are three major components for a video analytics system: core computation unit, web server, and database server. The database server and web server cooperate to store and visualize that are provided through a web-based interface to the user. The interface bridges the communication gap between the operators in Traffic Management Center (TMC) and the data from the on-site processor.

If the system is assigned an internal/public IP address, it can be easily accessed via that IP address by computers within the same internal/public network. If the system is not assigned an IP address it is always possible to run the system offline via a local host (127.0.0.1). The TxDOT demo system is designed to work on both video clips and streaming video, however, when the system is not assigned an IP address (i.e., is offline) it can only process video clips previously stored in the system and the email alert to administrators is disabled.

Besides power, the system requires an Ethernet cable to connect the system to the internal/public internet.

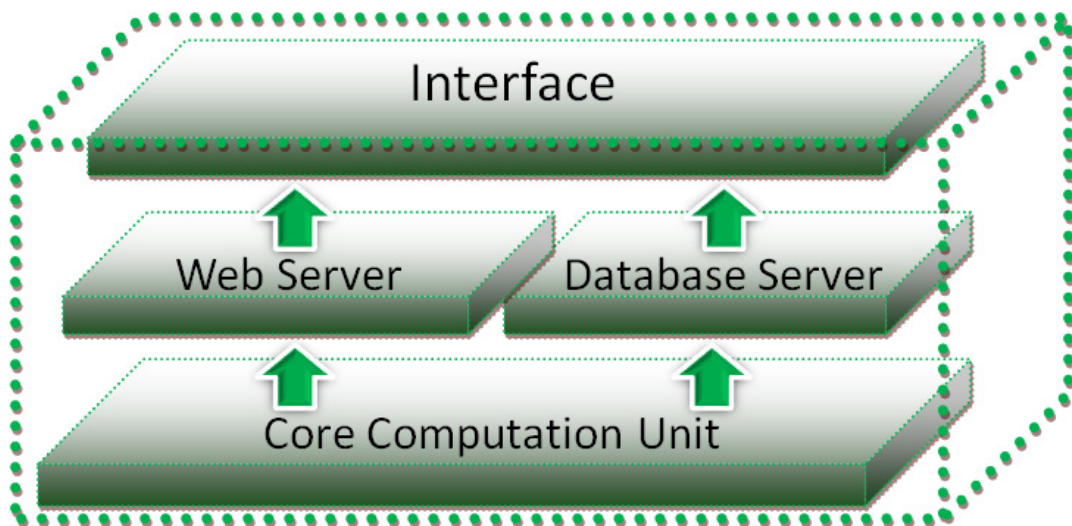


Figure 1.1 System functional structure

1.2 *System Interface Overview*

The TxDOT demo system can be configured and monitored using the interface. The TxDOT interface is a web-based application. It runs on the TxDOT system server. It is developed using HTML, CSS, JAVASCRIPT, and PHP.

The interface provides users with the capability to input a URL/video directory from which is obtained the video source. Via the interface, parameters for road structure, data view, and incident report can be easily set-up or modified. The real time traffic data such as speed and count is visualized as long as the camera is successfully calibrated. The interface has an execution section. Using it, one may start the program, end the program, view the last processed image, validate the detection zone automatically generated in the initialization phase, validate the road structure estimated, and view the last incident image. The interface not only provides snapshot views of the video processing but also provides a real time view of the processed frames. When the system detects an incident, it will send an email to an address previously designated in the interface section for parameters. A user can download both traffic data and incident records from the section named Download.

2 *Assumptions*

There are certain assumptions that underpin the TxDOT demo system. Placing the system in the right environment assures optimal performance. Assumptions include a valid video source, road structure constraints, camera perspective, conditions under which video analytics (VA) initialization occur, camera calibration validation, and operational details.

- Video Source

Whether the video source is a formatted stored video such as an avi file or streaming video, the frame rate should be at least 10 frames per second.

- Road Structure and Camera Perspective

In general, most roads, particularly freeways, conform to a uniform standard. A typical structure is illustrated in Fig. 2.1. As shown in Fig. 2.1(b) and (d) most highways are bidirectional (d1: oncoming traffic, d2: departing traffic) and the region of interest (ROI)—the road segment between the camera and the dashed line—is both straight and flat. Generally, we wish to monitor traffic in both directions. However, performance and coverage are trade-offs. When many lanes are under observation, the lanes farthest from the camera will incur occlusion. Thus, we suggest the maximum number of lanes observed to be four. When the total number of lanes exceeds the limit we suggest deploying two cameras, one to monitor the traffic in each direction.

Camera perspectives should be adjusted so that the highway lanes to be monitored should be in the center of the image as shown in Fig. 2.1(b) and (d). In Fig. 2.2, both poor and reasonable camera perspectives from different viewing angles are illustrated.

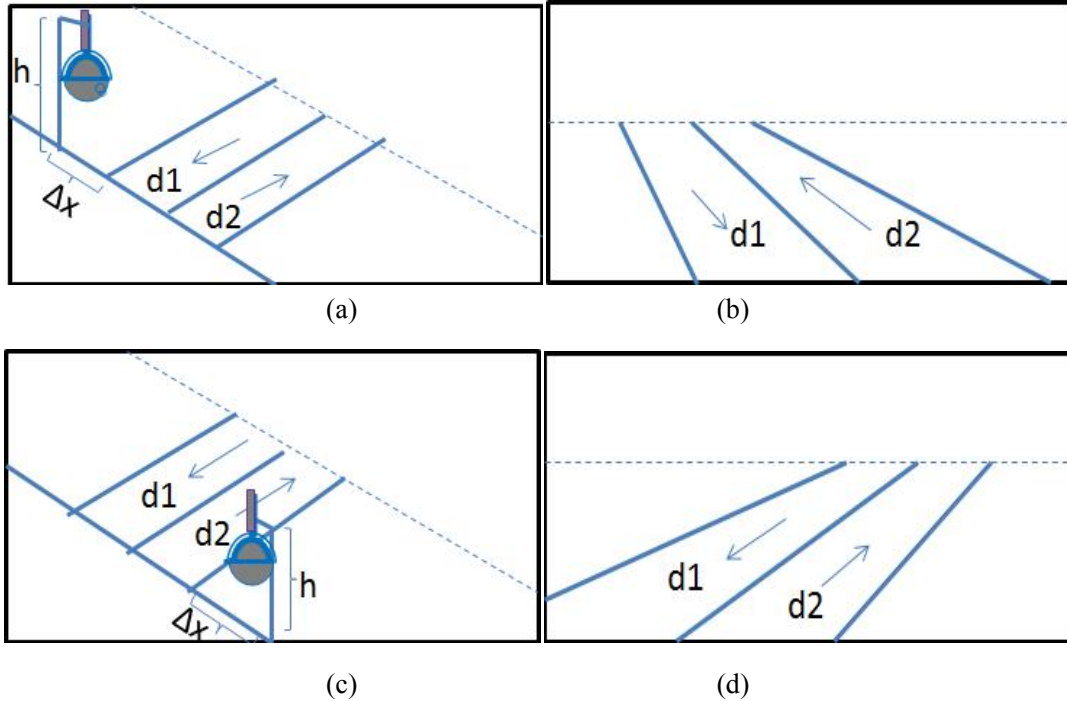


Figure 2.1 Typical road structure and camera location

(a) and (b) illustrate the typical practical camera location relative to the road; (c) and (d) show, respectively, the road structure captured in the camera view.



Figure 2.2 Camera perspective of different viewing angles

(a) camera perspective with low angle, that is, the height of the camera is inadequate; (b) camera perspective with far view, that is, Δx is too large (c) the ideal camera perspective

- VA Initialization

The VA Initialization phase is essential because understanding the road structure and camera calibration are two major tasks of the TxDOT demo system. In order to achieve optimal results for each task, the system should be initialized in normal

daylight condition with objects clearly visible and no shadows or, at most, short shadows as shown in Fig. 2.2(c). Afterwards the system should perform well in scenarios that are more varied. Each time the camera is repositioned, initialization must be performed by ending the current execution and restarting.

Note: The current system would require an upgrade for 1) achieving optimal accuracy for night-time scenarios; and 2) automatic analysis of scene characteristics to decide whether shadow removal is needed or not.

- Camera Calibration Validation

Intermediate results can be viewed to estimate how well the road structure is understood. This directly reflects camera calibration accuracy. Looking at Fig. 2.3 (a) the straight blue lines are acquired from trajectories of vehicles collected in the initialization phase and the straight green lines indicate the average path taken by vehicles traveling through the same lane. The detection of blue and green lines should be validated such that most of the lines cross the black vanishing point without much noise and such that the two paths closest to the camera side should be validated for its reasonableness (the real-world distance between these two lines should be close to the real-world lane width). What is more the size of detection zones generated for each path should be also be reasonable with respect to perspective as in Fig. 2.3(b).

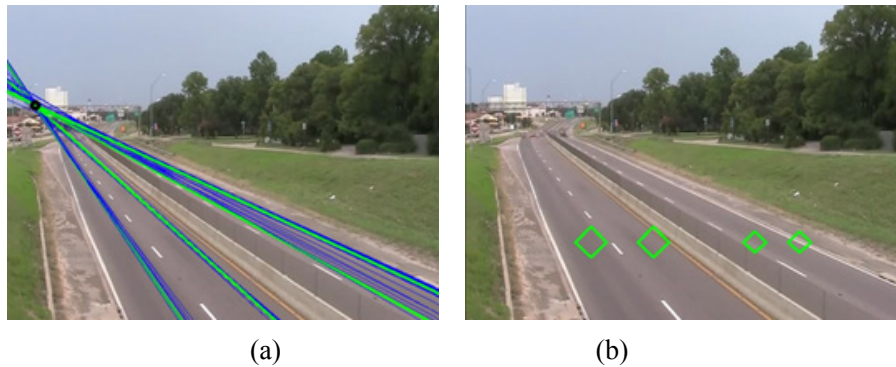


Figure 2.3 Intermediate results

(a) Dominant paths learned from clustering collected trajectories; (b) Detection zones generated automatically.

- Operation Details

All settings or parameters changes should be done prior to the start of the program. Any changes after the execution of the program will not affect the output. It is suggested that users should end the program and restart it if settings or parameters provided are incorrect.

3 Interface

For convenience, the TxDOT system provides the user with a web-based interface. Users can modify the parameters, view the snapshot of selected web cams, discover the road structures, start and end the system, view traffic data, download the data, look at the vanishing point and detection zones generated to see how well the camera is calibrated, view a snapshot of the latest incident, and see the snapshot and real time view of the processed traffic videos.

The interface is comprised of the following sections: parameter settings, different levels of data view, system control, and data download. This manual guides users in the use of each section.

3.1 Parameter Settings

Before placing the system into operation, one should first set the parameters. Several steps are required.

1) Camera Settings:

By clicking the CameraIP tag at the right side navigation bar, one can reach the page for setting the parameters for the camera.

On this page, the TxDOT system allows a user to choose either streaming video directly from the traffic camera or video clips stored on the server.

The user can use the radio button (Figure 3.1) to choose either video clips or streaming video.



Figure 3.1 Choosing the video type for the camera under settings

After choosing the video resource type, a user should input the address of the video as in Figure 3.2.

Streaming Video URL\Video Directory:

Snapshot URL\Video Directory:

Figure 3.2 The two text inputs for the address of the video

If the video source is a stored avi file, the user should type the video directory in both of the text input lines that follow the radio button.

For example, if the user has a video on the server and the directory of the video is:

/home/txdot/Desktop/VIDEOS/video1.avi

Then the user should type the address of the directory into both text-input lines.

If the video source is streaming video from an IP camera, URLs for accessing it and snapshots should be provided.

When finished, click the Confirm button to submit changes. Otherwise, all inputs will be ignored.

2) Road Structure Settings:

By clicking the RoadStructure tag in the navigation bar at the right side of the page, one can reach the page to describe the road structure. It has two basic components. One refreshes the snapshot taken from either the video clip or the IP Camera. The other allows a user to modify the parameters of the road structure as shown in Figure 3.3.

Through the snapshot, one can detect information useful in specifying the parameters for the road structure. However, sometimes, the frame taken from the video clips or streaming videos is not clear or fails to satisfy the requirements explained previously. With the refresh button, the user can continue refreshing until a better one is obtained.

Using the snapshot, one can discover how many lanes exist for each traffic direction, the lane width, the perpendicular angle, top (boundary) ratio, bottom (boundary) ratio, left (boundary) ratio, right (boundary) ratio, and whether the vehicles are casting shadows. The boundary ratios (top, bottom, left, and right) are parameters used for capturing the region of interest as explained below.

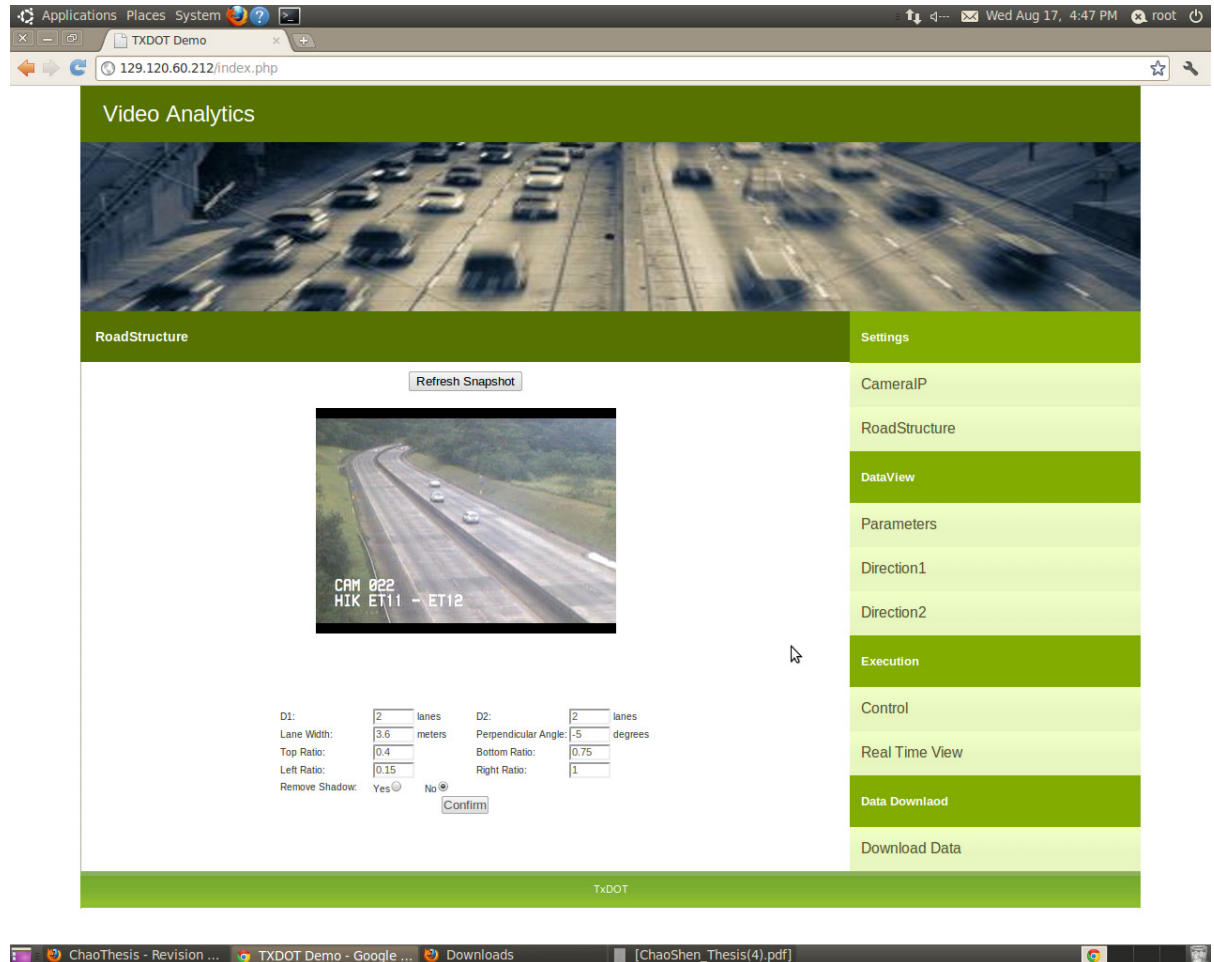


Figure 3.3 Road structure parameters

- D1: The direction of oncoming traffic. The user should input the number of lanes in direction D1.
- D2: The direction of the departing traffic. The user should input the number of lanes in direction D2.
- Lane Width: The real-world lane width. The user should consult the highway lane construction standards in order to provide the best estimate.
- Perpendicular Angle: The front edge of the wind shield of a medium-sized vehicle can be utilized for perpendicular angle estimation. The target vehicle should be in the lane nearest the roadside at which the camera is mounted. The target car should be nearing departure from the scene (if an oncoming lane) or just entering the scene (if a departing lane) as shown in Fig. 3.4. In the figure, the relative angle between the leading edge of the wind shield is marked in red. The lower horizontal edge is in blue. The angle between the red and blue lines is the perpendicular angle estimate. The angle should be expressed as a negative value if the camera is on the left of the highway and positive otherwise. This

parameter is extremely important for camera calibration and thus speed estimation. The more accurate it is the more accurate the speed estimation will be.



Figure 3.4 Perpendicular angle estimation

- Region of Interest (ROI): As illustrated in Fig.3.5, the top (boundary) ratio, bottom (boundary) ratio, left (boundary) ratio, right (boundary) ratio can be specified with respect to the region chosen for processing.

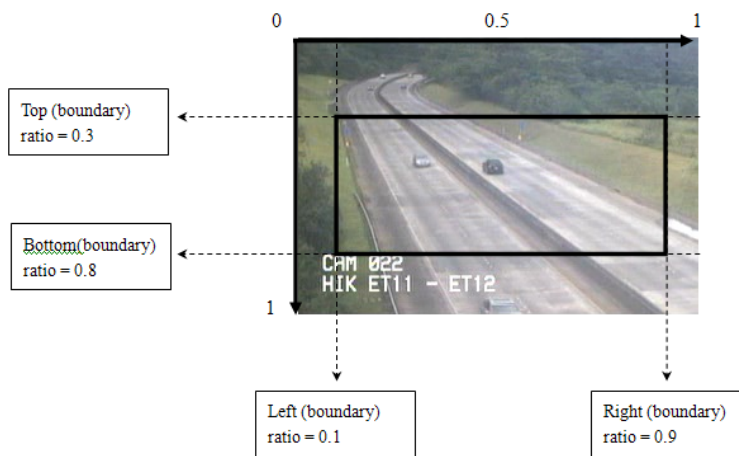


Figure 3.5 Region of interest specification

- Remove Shadow: Check whether the current view has shadows or not. The user can detect whether a car has a shadow or not from the snapshot.

3) Information Settings:

Other than the parameters describing the video source and road structure, other information must be provided such as the email of the recipient for incident detection, frequency with which speed and count are updated, and the duration threshold for stopped car detection. The table for specifying these parameters is shown in Fig. 3.6.

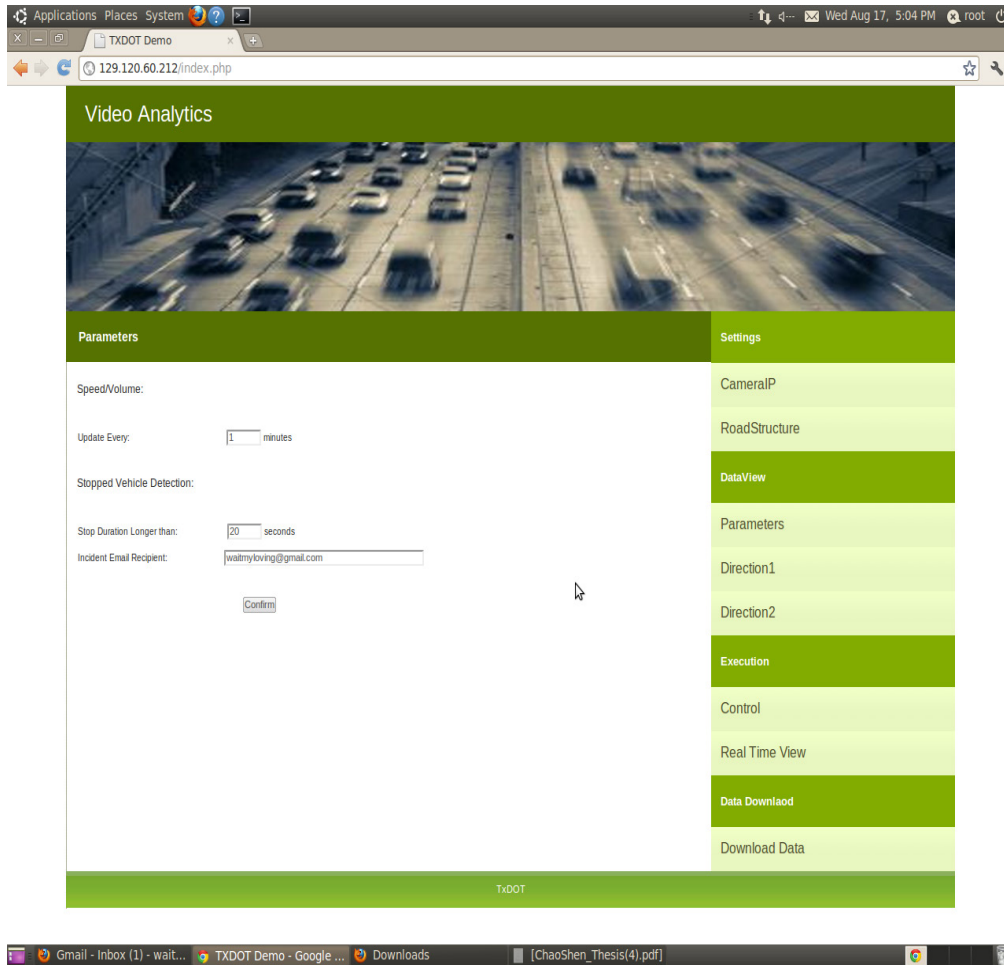


Figure 3.6 Parameters under DataView

3.2 *Execution*

Click the Control link in the navigation bar to obtain access to the page shown in Fig. 3.7. By clicking “start the program” button, the video analysis processing core unit will begin execution. One can then access the real time view to check the processed video.

After the program begins, it takes time for the camera to become calibrated. That is, the system is in its initialization phase. If the user provided a good estimation for the road structure, initialization will take less time.

To terminate execution, the user can click the “end the program” button.

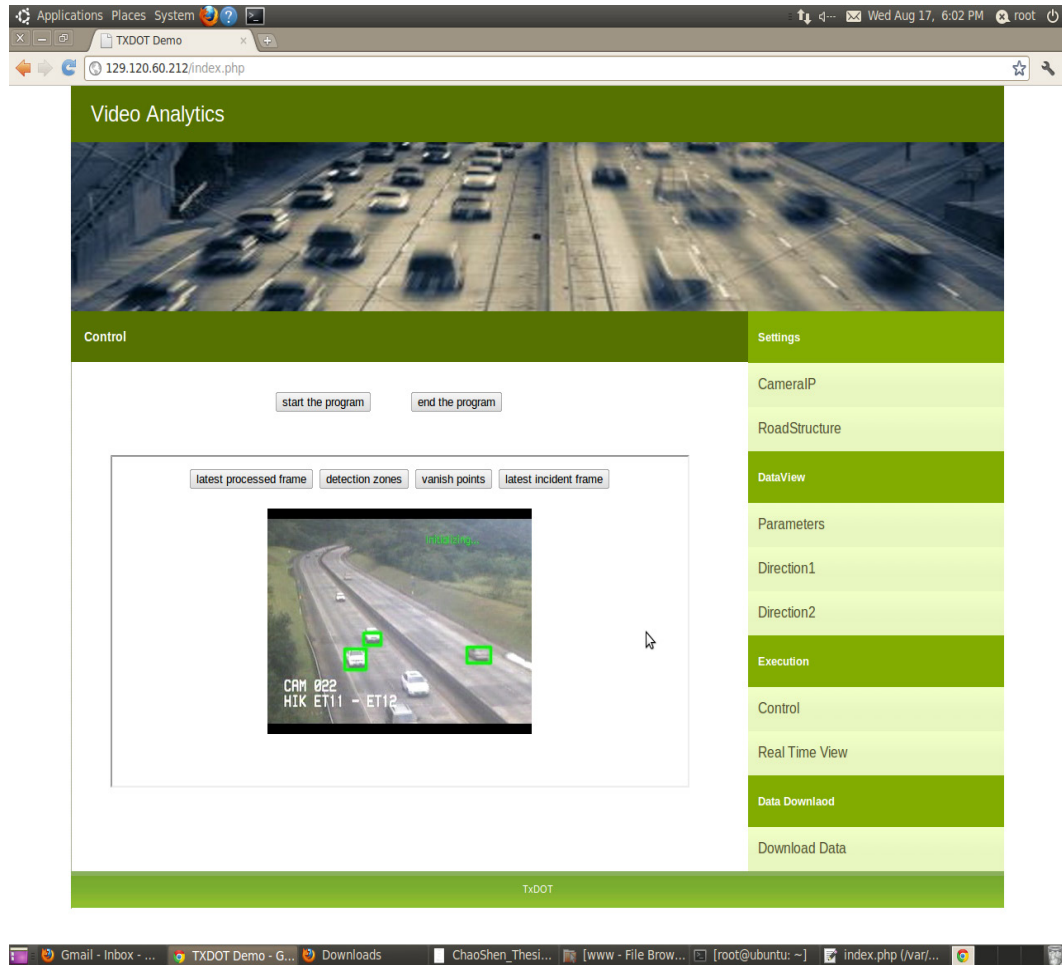


Figure 3.7 System control

3.3 Visualization

The TxDOT system interface provides different types of data views. These include a histogram view for traffic in both directions, a snapshot view of the last processed image, the detection zones, the vanishing points generated, the last detected incident frame, and a real time view of the processed video.

1) Histogram View:

The speed and count for both directions (D1: oncoming traffic and D2: departing traffic) is available. The most recent 10 records will be displayed but all data will be available in the database. In Fig. 3.8, illustrative traffic data are displayed for direction D1.

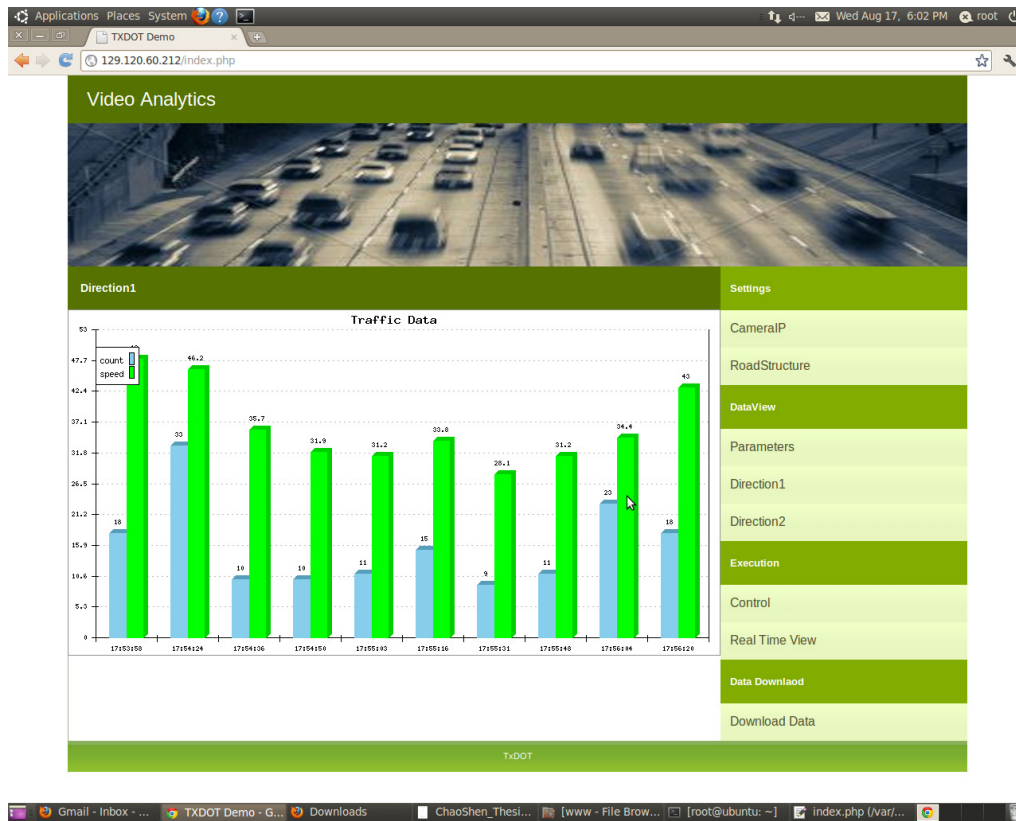


Figure 3.8 The histogram view for traffic data for direction D1

2) Snapshot View:

If one clicks Control under the Execution tab the page shown in Fig. 3.7 will appear. It shows the last processed frame, generated detection zones, the vanishing point detected, and the last incident detected frame can be accessed by clicking corresponding buttons.

3) Real Time View:

By clicking the Real Time View link in the navigation bar, the user can reach the page showing real time views. Fig. 3.9 shows the page. Click the Back To Main Page to return to the main page.



Figure 3.9 Real time view

3.4 Data Download

The collected traffic data can also be downloaded, including incident reports, by clicking the Data Download link in the navigation bar as shown in Fig. 3.10.

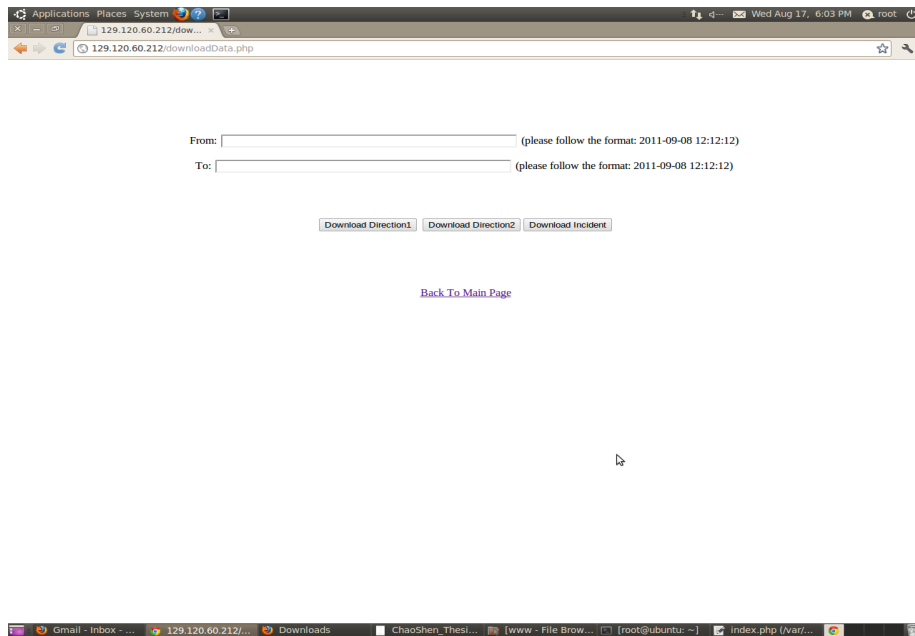


Figure 3.10 Data download

There are two text-input lines at the top of the page. The user can type the time interval from which to fetch the data records. The input format should follow the scheme: YYYY-MM-DD HOUR:MINUTE:SECOND.

After the two text-input lines, there are three buttons: Download Direction1, Download Direction2, and Download Incidents. By clicking the appropriate button, the user can download corresponding data records over the defined time interval in the database.

For example, if a user wishes to fetch direction 1's data records from July 12, 2011, beginning at time 1:12:45 p.m. to July 12, 2011, at time 9:43:15 p.m., the user can type 2011-06-12 13:12:45 into the first text-input line and type 2011-06-14 21:43:15 into the second text-input line. Then the user only needs to click the Download Direction1 below the text input to download the corresponding data from the database. After clicking the button, there will be a dialog box. The user only needs to click save in order to store the data in .txt format.